2014

Prime Hook National Wildlife Refuge

Submitted by Wildlife Biologist
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[ANNUAL HABITAT WORK PLAN - 2014]

AHWP describes the Habitat and Wildlife Responses to Management Actions and Weather Conditions of 2013 and Planned Habitat Management Strategy Prescriptions and Actions for 2014 that are related to achieving HMP Goals and Objectives

Photo by Volunteer Julie McCall taken in winter of 2012 at Unit III of the Prime Hook National Wildlife Refuge Milton, Delaware.

Pintails have no worries as they calmly swim by because Bald Eagle is feasting its eyes on fat and succulent greater snow geese.

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Annual Habitat Work Plan (AHWP) 2014

I. Relationship to the HMP

The AHWP is directly related to Prime Hook NWR's Habitat Management Plan (HMP) and indirectly to the CCP. The AHWP summarizes the prior year's habitat management and monitoring actions and subsequent wildlife responses. It also serves as an annual planning tool that delineates specific details of incremental tasks for 2014 in support of habitat and wildlife goals and objectives contained in the CCP and stepped down into the HMP.

II. Habitat Objectives

This year the habitat management strategies that are to be completed in 2014 as described in this report correspond to one barrier island, one wetland and three upland habitat management objectives. These are listed below: (Note: Goal and Objective statements can be viewed in full in Appendix A)

- Objective 1.1 (Barrier Beach Island Habitat)
- Objective 2.2 (Mixed Hardwood Forest Restoration)
- Objective 3.2 (Manage water quality for trust fisheries resources, migrating birds and resident wildlife
- Objective 4.1 (Transitional Habitats: Grasslands, Shrubland and Young Trees)
- Objective 4.2 (Specific Grassland Bird Habitat Management)

III. Habitat Response

This section of the AHMP evaluates progress toward achieving habitat management objectives listed above and corresponding CCP Habitat Goals from a review of habitat monitoring tasks conducted in past two years and from the results of habitat management actions performed in CY 2013. It also relates abiotic and biological habitat responses and conditions and subsequent monitored wildlife responses described in section IV of this report. Habitat responses to management actions conducted in 2013 create the foundation to develop habitat management actions and specific scheduled habitat management prescriptions for 2014 described in sections VI and VII.

Water Level and Salinity Monitoring

Water level and salinity data have been summarized and charted to map out average trends and extreme fluctuations experienced in 2013. An automated YSI Sondes Monitoring Network established on

the refuge in October 2010 captures the major water flows (in meters), water levels and water column salinity values in Units II and III from seven strategic locations.

Negative ecological effects experienced in 2011 and 2012 in Unit III (extreme salinity swings, fish kills, severe marsh soil desiccation, high water temperatures and low dissolved oxygen concentrations) resulted from creating very low water level conditions, when rapid drawdowns were conducted and low water levels were maintained during the spring and summer. For example DNREC's Fisheries Section documented a Fish-Kill Event on the refuge on 07/25/2011 responding to public complaints. Mortality was documented for the following species; Blue crab (1200), Atlantic menhaden (50), Atlantic silversides (100), American eel (30) and mummichog (800). Documented causes in DNREC's report were a combination of low water levels, high water temperatures and low DO levels. Also, during the growing seasons of 2011 and 2012 extreme salinity swings in Unit III excluded opportunities for any annual wetland plants to emerge.

We have successfully avoided and mitigated these negative effects in 2013 by maintaining higher water levels (near 2.6 foot mark) at Petersfield WCS in Unit III from June through September. Deed restrictions were addressed by Refuge Managers who discussed this water level management strategy with the local landowner and his approval helped us to realize positive benefits not only to fisheries resources but also resulted in positive vegetation responses in Unit III as a result of this water level management strategy.

Positive outcomes included reduced water salinities in Unit III throughout the growing season, moist soil conditions maintained during the months of greatest evapotranspiration rates and more robust annual vegetation plant responses compared to prior years. By not conducting rapid drawdowns during the spring and summer and not constantly flushing Unit III with high saline waters originating from Unit II, extreme salinity swings experienced in 2011 and 2012 were also avoided.

We successfully maintained the water levels above 0.4 and between 0.5 and 0.6 meters (~ 2.6 to 2.7 msl feet at gage on WCS) which resulted in recorded water salinities staying below 10 ppt and average around 5 ppt from May through August (See Hydrograms for Headquarters Site for water levels and water column salinities below). This was in contrast to prior years where average salinities were around 20 ppt and peaks up to 32 ppt during the growing season in Unit III.

Figure 1. Water Level Hydrogram from Sondes Data for Unit III Central

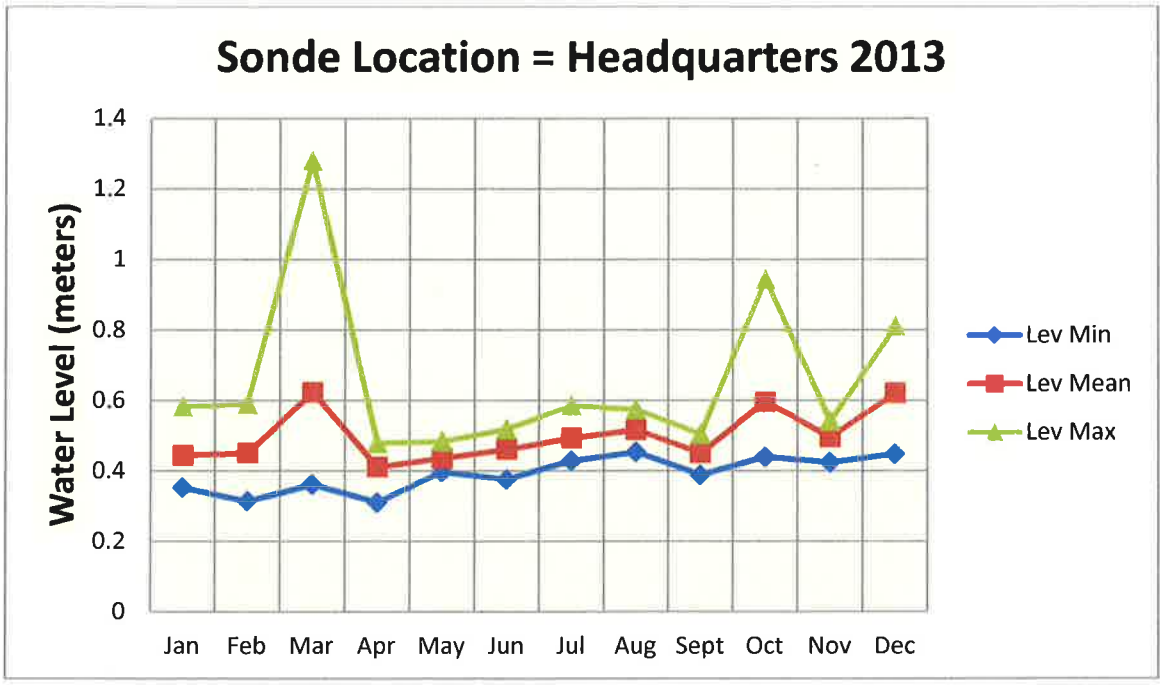
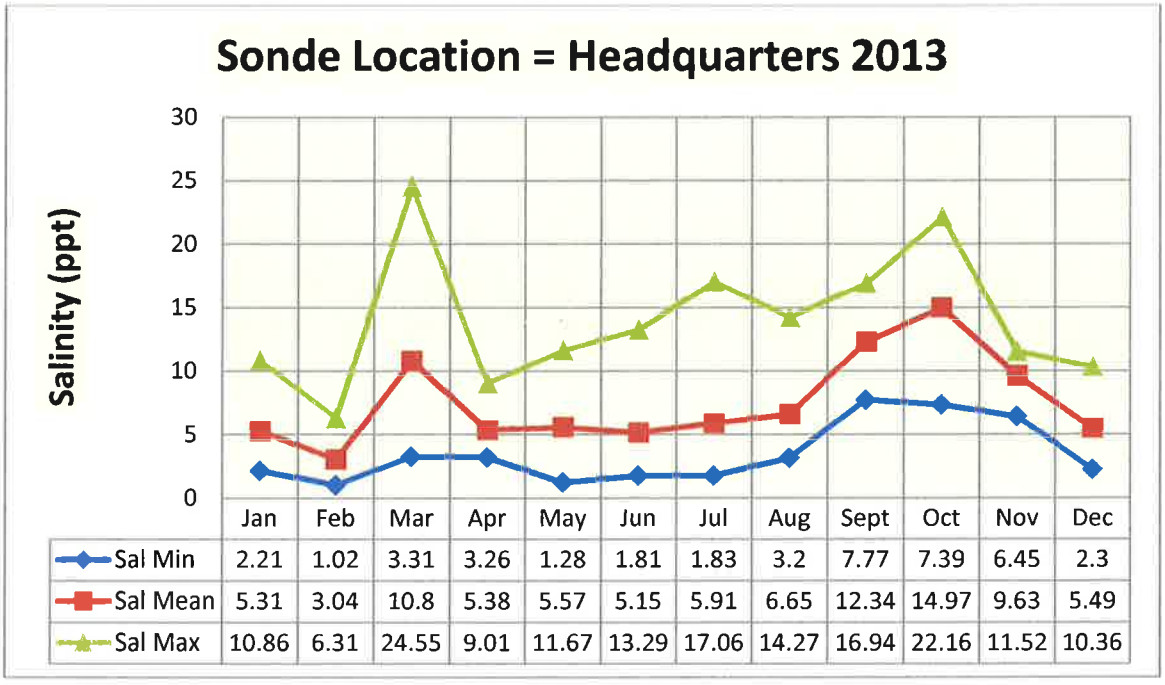
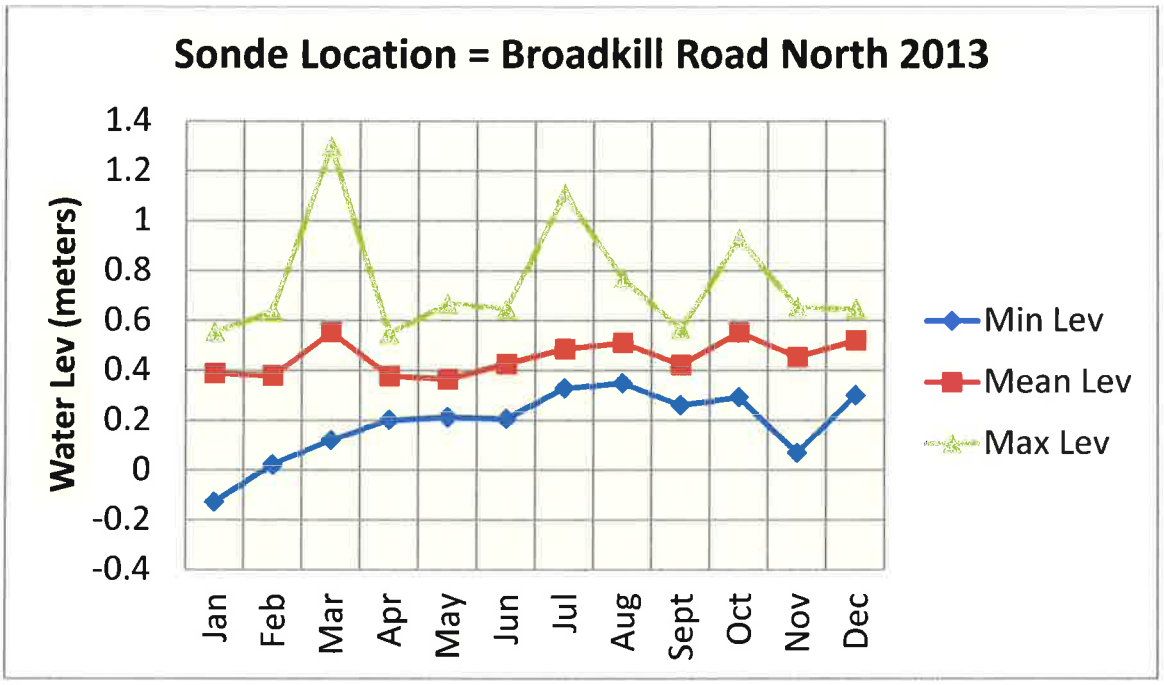


Figure 2. Water Column Salinity from Sondes Data in Unit III Central



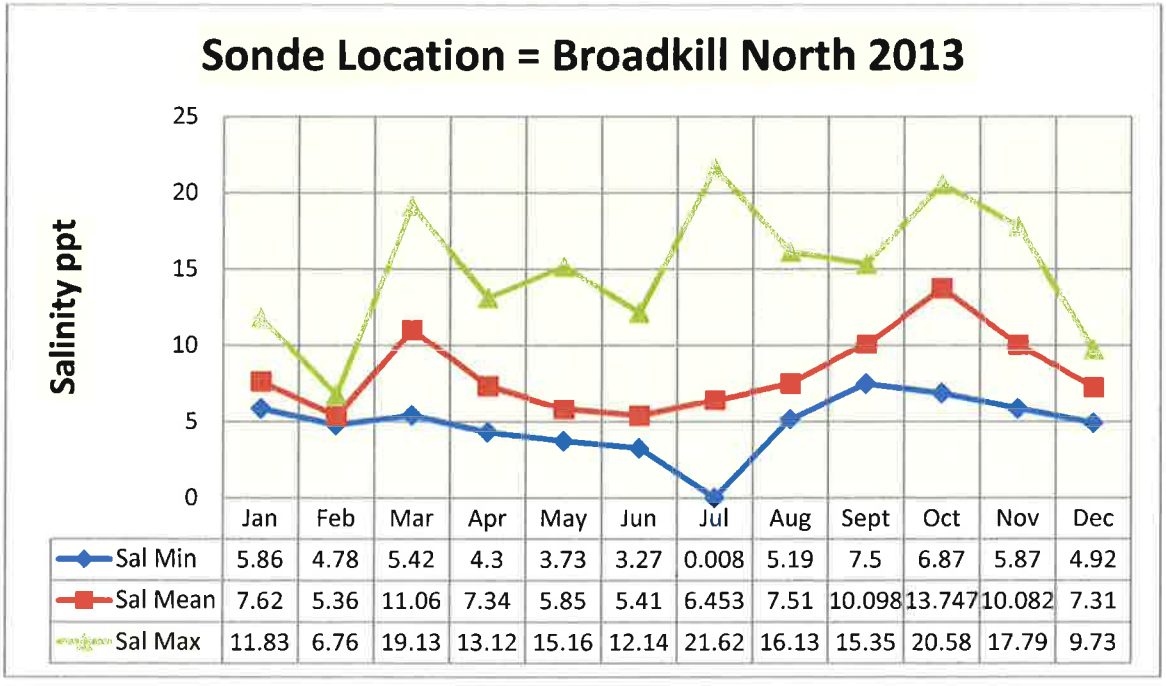
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Sal Min	2.21	1.02	3.31	3.26	1.28	1.81	1.83	3.2	7.77	7.39	6.45	2.3
Sal Mean	5.31	3.04	10.8	5.38	5.57	5.15	5.91	6.65	12.34	14.97	9.63	5.49
Sal Max	10.86	6.31	24.55	9.01	11.67	13.29	17.06	14.27	16.94	22.16	11.52	10.36

Figure 3. Water Level Hydrogram from Sonde Data in Unit III-South



When examining water level hydrograms for the other six sonde locations, high water level peaks and corresponding salinity spikes are evident at all locations. Three spikes or peaks of highest water levels moving through the marsh system represent northeaster events in March and October and king tide in July coupled above normal rainfall. The subsequent opening of all water control structures to reduce water levels below the 0.6 meter mark is also apparent in rapid water level drops of maximum level data line depicted in each graph-sonde location (Compare Figures 1 – 7 and 2013 rainfall data on page 31).

Figure 4. Water Column Salinity from Sonde Data in Unit III South



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Sal Min	5.86	4.78	5.42	4.3	3.73	3.27	0.008	5.19	7.5	6.87	5.87	4.92
Sal Mean	7.62	5.36	11.06	7.34	5.85	5.41	6.453	7.51	10.098	13.747	10.082	7.31
Sal Max	11.83	6.76	19.13	13.12	15.16	12.14	21.62	16.13	15.35	20.58	17.79	9.73

Figure 5. Water Level Hydrogram from Sondes Data for Unit III North

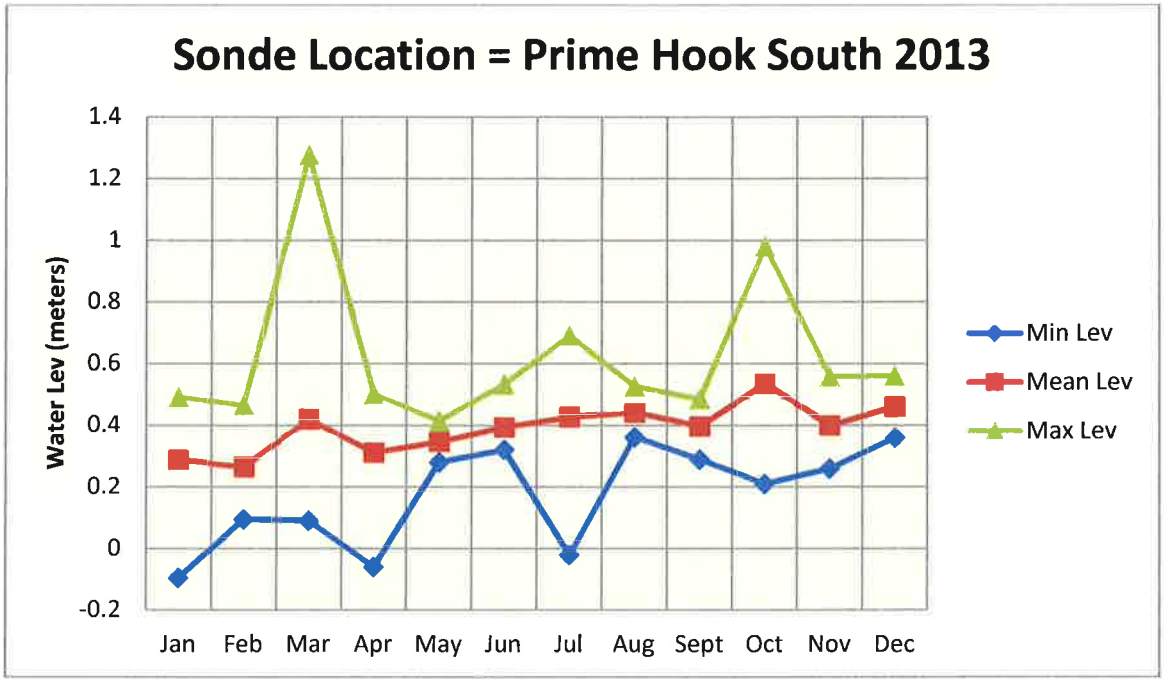
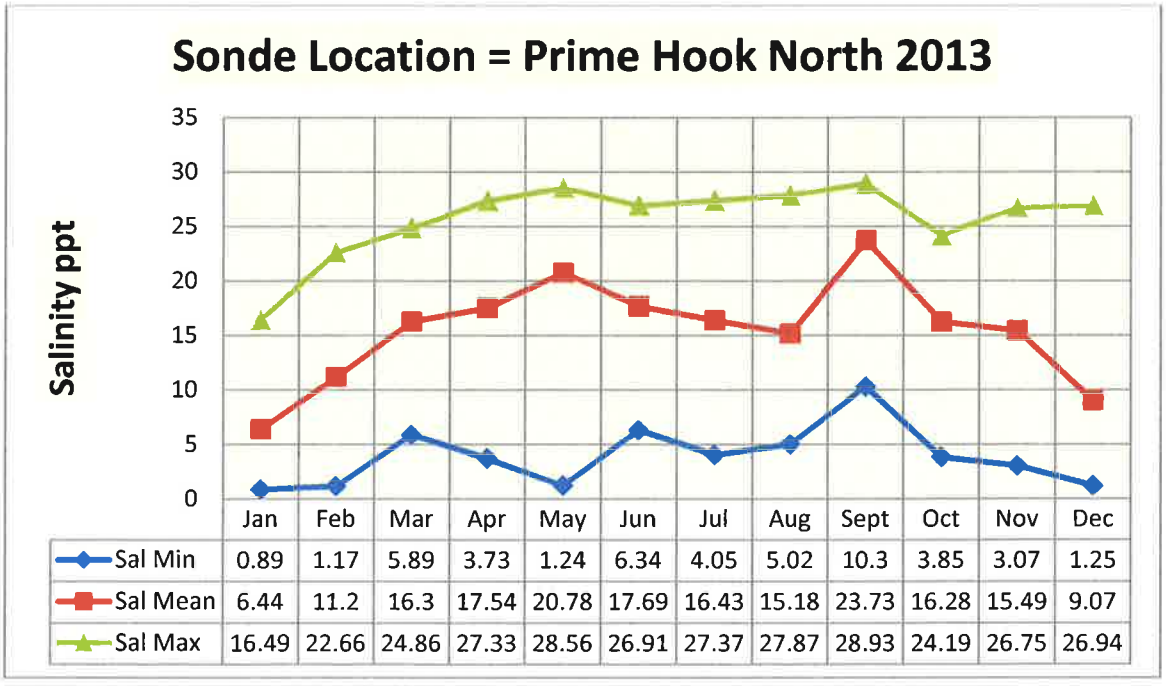


Figure 6. Water Column Salinity from Sonde Data for Unit III North



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Sal Min	0.89	1.17	5.89	3.73	1.24	6.34	4.05	5.02	10.3	3.85	3.07	1.25
Sal Mean	6.44	11.2	16.3	17.54	20.78	17.69	16.43	15.18	23.73	16.28	15.49	9.07
Sal Max	16.49	22.66	24.86	27.33	28.56	26.91	27.37	27.87	28.93	24.19	26.75	26.94

Figure 7. Water Level Hydrogram from Sonde Data for Unit II North

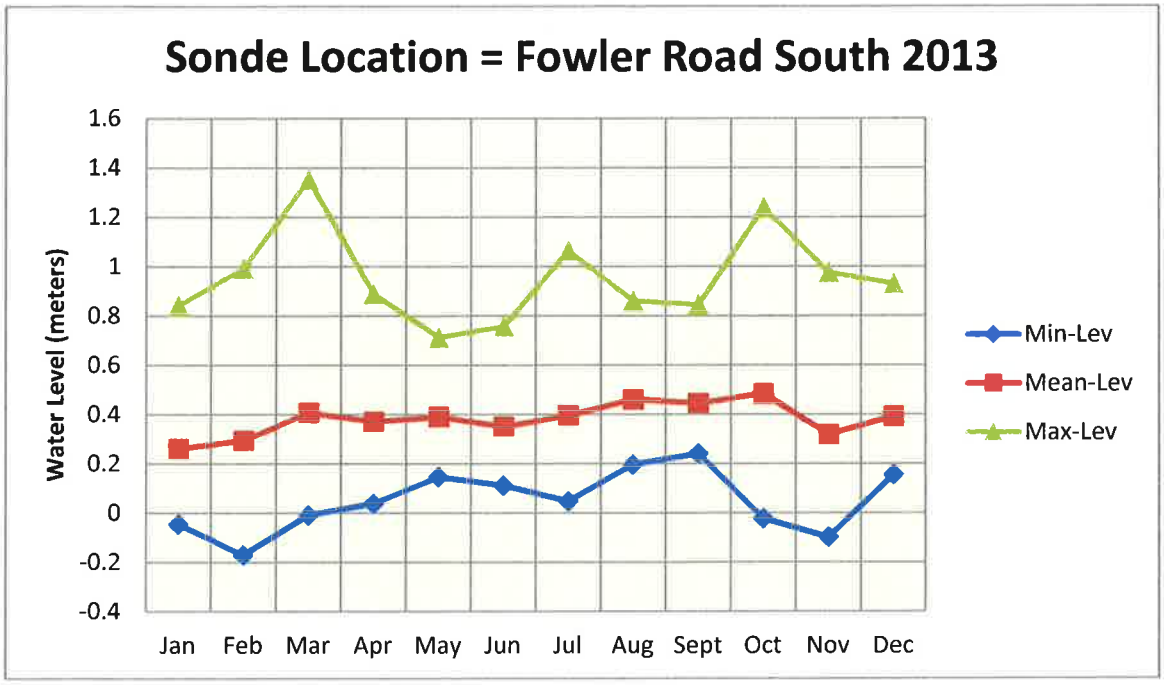
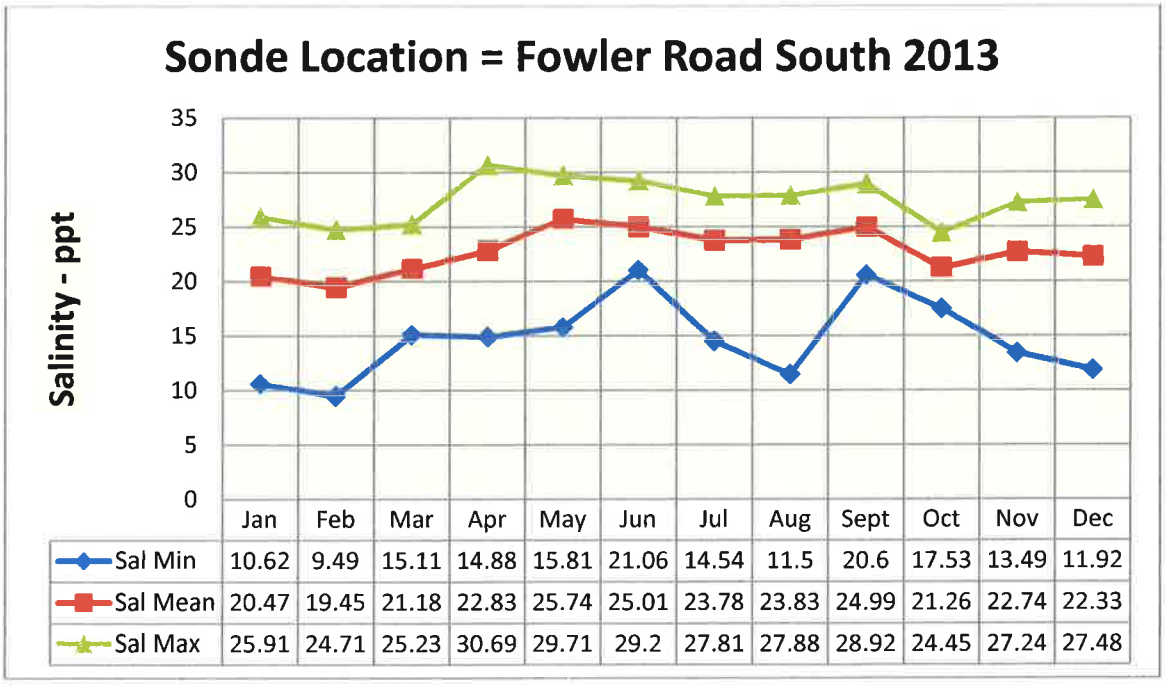


Figure 8. Water Column Salinities from Sonde Data in Unit II North



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Sal Min	10.62	9.49	15.11	14.88	15.81	21.06	14.54	11.5	20.6	17.53	13.49	11.92
Sal Mean	20.47	19.45	21.18	22.83	25.74	25.01	23.78	23.83	24.99	21.26	22.74	22.33
Sal Max	25.91	24.71	25.23	30.69	29.71	29.2	27.81	27.88	28.92	24.45	27.24	27.48

Habitat Surveys

Prime Hook NWR has recently (October 2010) re-structured its habitat and waterbird monitoring methodology to coincide with Region 3 and Region 5 **INTEGRATED WATERBIRD MANAGEMENT AND MONITORING PROGRAM (IWMM)**. The goal of the IWMM program is to conserve continental populations of waterbirds across two flyways (Atlantic & Mississippi) when USFWS regional biologists recognized that wildlife managers needed consistent bird data to consolidate decision-making from three spatial scales: Flyway, state or regional, and local levels.

The objective of the IWMM Program is to standardize bird and habitat monitoring surveys and reporting protocols. Comprehensive IWMM data collection includes both on and off refuge lands monitored throughout the two flyways. Within the IWMM database the refuge Identifier Unit is (DE_002) with subunit census areas delineated across Management Units II, III and IV. Six "whole area Count" sites were selected by the refuge biologist to represent the formally intact freshwater impounded infrastructure encompassing 4,200 acres across Prime Hook's marsh landscape.

IWMM bird surveys focus on wetland-dependent migratory birds (waterfowl, shorebirds, waders) during winter and migration with associated seasonal habitat surveys. These habitat surveys are conducted to provide rapid assessment of available habitat conditions, habitat quality and water-bird responses to individual wetland management actions. This is accomplished by conducting both bird and vegetation surveys in relatively small and homogenous census units that represent large management areas. The size and locations of Prime Hook's whole count survey areas are described in Table 1 and depicted on Prime Hook NWR Marsh and Water Monitoring Map in the Appendix B .

Table 1. Prime Hook NWR's IWMM Program Census Unit Descriptions

IWMM Census Name	Location Description	Whole-Area Count Size (acres)
DE_002F	Unit II North – Breach Area	30
DE_002E	Unit II South – Near Prime Hook Road	150
DE_002D	Unit III North – Near Prime Hook Road	210
DE_002A	Unit III Central – Off Dike Road	70
DE_002B	Unit III South – Near Route 16	60
DE_002C	Unit IV – Near Route 16	60

Vegetation surveys are conducted seasonally:

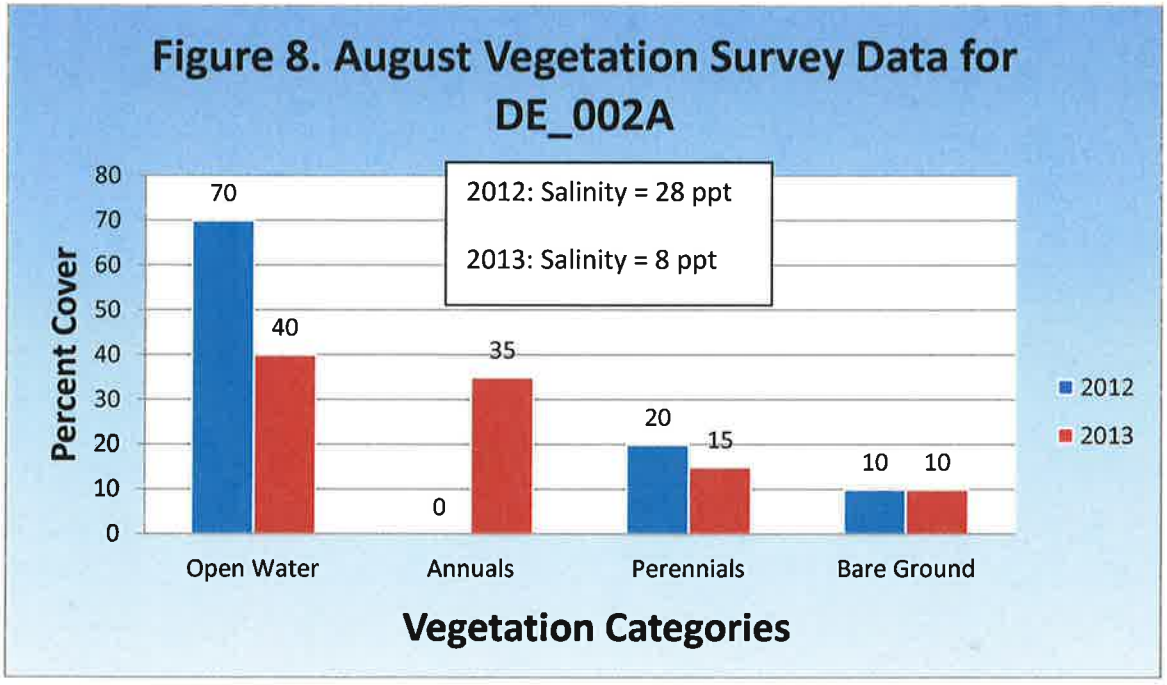
1. End of February
2. Mid-April
3. August
4. End of October

IWMM vegetation surveys match bird counts to habitat characteristics by measuring the following parameters:

- Salinity
- Top Four Co-dominant wetland plants
- Percent Cover

- Availability of Preferred Waterfowl Food Plants
- Vegetation Height
- Seed Head Index
- Habitat Interspersion: defined as the intermix of different habitats types within survey area

Positive vegetation responses especially in Unit III were noted and recorded as a result of changing water level management strategies in 2013. For the first time in three years small stands of wild millet, nut sedge and spike rushes were able to recolonize areas in DE_002A and DE_002B. Large patches of *Spartina patens* were denuded by extensive snow goose herbivory in the early winter months. These "eat-out" areas were readily replaced with robust annual vegetation due to significantly reduced salinities and created moist-soil conditions during the growing season in response to keeping water levels high in Unit III. Comparison of vegetation cover categories in DE_002A between 2012 and 2013 showed significant drops in open water coverage from 70% down to 40% and increases in annual plant percent cover from 0 to 35 % (see chart on next page). Also of note were large sections of *Spartina alterniflora* that recolonized bare ground spots in DE_002F survey area attributed to rapid changes in breach and shoreline configurations depositing some sediment into Unit II. Note photo-documentation of two surveyed areas showing some of these seasonal vegetative responses in 2013 to water level management actions and barrier island dynamics.



2013: Top Co-Dominant Plants DE_002A*

1) Cyperus esculentus
2) Eleocharis parvula
3) Panicum dichotomiflorum
4) Phragmites australis

2012: Top Co-dominant Plants DE_002A

1) Spartina patens
2) Phragmites australis
3) Dead Typha

*Other Plant species also present in DE_002A in 2013 included listed species below not present in 2012.

*Scientific Name	Common Name	Waterfowl Food Value
Amaranthus cannabius	Water Hemp	Medium
Cyperus erythrorhizos	Redroot flatsedge	High
Echinchola walteri	Barnyard grass	High
Eleocharis quadrangulata	Foursquare spikerush	High
Ludwigia palustris	Pennywort	Low
Pluchea odorata	Saltmarsh fleabane	Low
Polygonum hydropiperoides	Swamp smartweed	High
P. pensylvanica	Pinkweed	High
Rumex spp.	Dock	Medium
Scirpus validus	Softstem bulrush	Medium
S. americanus	Three-square	Medium
Sesuvium maritimus	Sea purslane	Low
Spartina patens	Salt meadow grass	Low
Typha spp.	Cattail	Low
Leersia oryzoides	Rice Cutgrass	High
Spartina cynosuroides	Big Cordgrass	High
Setaria magna	Giant Foxtail	High

Figure 10. Robust stands of Chufa (nutsedge) in foreground and background patches of dwarf spike-rush in Vegetation Survey Area of DE_002A during 2013 growing season.

Figure 11. *Spartina alterniflora* recolonizing patches of Bareground in DE_002F during 2013 Growing Season

As expected high salinity values in the other survey units in Unit II resulted in little to no significant changes of the top four co-dominant plants when comparing 2012 and 2013 habitat responses. The percent cover of open water remained consistently high (55 to 80%). It should also be noted that Unit IV has little opportunity to re-vegetate during summer months due to the complicated failure of both small water control structures that were retrofitted with individual stop-log flap gates in 2005. Dysfunctional WCSs and plugged ditches do not allow Unit IV to drain so high water levels persist all year round and the percent cover of open water (90% - 100%) remains constant. Stable water levels provide little opportunity for annual wetland plant growth but maintain excellent habitats of invertebrates.

Vegetation Cover Mapping Results

A study project to perform historical vegetation analysis and map current habitat condition of refuge vegetation communities and land covers of Management Units I, II and III was completed on October 10, 2013. Vegetation communities and land covers were determined by qualitative analysis using observations made in the field and aerial photo-interpretation using 1937, 2002, 2007 and 2012 imagery. Habitat communities were named using the ***National Vegetation Classification System*** **(NVCS)**. Land cover-types followed the ***Coastal and Marine Ecological Classification Standard*** **(CMECS-2012)**. See Appendix C for CMECS classifications and nomenclature for refuge management Units I, II, and III.

Historical imagery analysis generated vegetation cover maps for all three units for the above mentioned years which were used to compare vegetation and land cover changes over a 5, 65, 70 and 75 year time-

frame. The project provides extensive pre-restoration baseline data for planned restoration activities for Units II and III. A sea level rise analysis was also performed on the vegetation communities and land covers on the refuge using DNREC's Sea Level Rise Scenarios. An estimate of the potential acreage loss for each cover-type found on the refuge under various sea level rise flooding scenarios was also provided in the vegetation mapping study report (Coxe - 2013).

Summary of Vegetation Mapping and Habitat Condition Findings

Thirty-eight vegetation communities and seventeen land covers were found on the refuge within Units I, II and III. The NVCS classifies vegetation using a uniform national and international system that also helps to determine relative rarity across state, national and global vegetative landscapes. Extensive descriptions of the vegetation communities can be found in Chapter 5 of the report (Coxe 2013).

On the next page is a list of the specific NVCS Association Number representing each distinctive vegetation community found on the refuge along with their common names and approximate acreages. Acres of historic vegetation communities are given by year and an analysis was conducted to determine what became of prior vegetation communities (losses) and which communities have converted to other habitat-types (gains). For each vegetative community description in Chapter 5, a crosswalk was also made to both the Delaware Wildlife Action Plan (DEWAP) and the Northeast Habitat Classification (NHC) nomenclature. Mapping results for 2013 showed that Northeastern Old Field (904 acres) was the largest vegetation community cover-type on the refuge followed by North Atlantic Low Salt Marsh (805 acres).

In 2014, we will be concentrating on upgrading and enhancing the BIDEH of many of the refuge's early successional old field habitats that have been neglected far too long (See Section Unmet Habitat Needs). The largest land cover-types included Estuarine Coastal Mesohaline Water (1,447 acres) followed by Estuarine Coastal Polyhaline Water (1,091 acres) which represent significant emergent wetland losses and gains in saline open water cover-type.

The NVCS vegetation communities describing current habitat conditions as of end of 2012 included:

1. Atlantic White Cedar-Seaside Alder Woodland (CEGL006307)—2 acres
2. Beachgrass-Panicgrass Dune Grassland (CEGL004043)—31 acres
3. Buttonbush Coastal Plain Pond (CEGL006242)—0.4 acres
4. Chesapeake Bay Non-riverine Wet Hardwood Forest (CEGL004644)—145 acres
5. *Cladophora* Mat (No NVC Classification)—7 acres
6. Coastal Loblolly Pine Wetland Forest (CEGL006137)—61 acres
7. Coastal Plain Oak Floodplain Swamp (CEGL006605)—6 acres
8. Cultivated Lawn (CEGL006486)—23 acres
9. Early to Mid-Successional Loblolly Pine Forest (CEGL006011)—56 acres
10. Eastern Reed Marsh (CEGL004141)—27 acres
11. Irregularly Flooded Eastern Tidal Salt Shrub (CEGL003921)—5 acres
12. Loblolly Pine/Wax-myrtle/Salt Meadow Cordgrass Woodland (CEGL006849)—1 acre
13. Maritime Red Cedar Woodland (CEGL006212)—5 acres
14. Mid-Atlantic Mesic Mixed Hardwood Forest (CEGL006075)—41 acres
15. Mid to Late Successional Loblolly Pine-Sweetgum Forest (CEGL008462)—39 acres
16. North Atlantic High Salt Marsh (CEGL006006)—2 acres
17. North Atlantic Low Salt Marsh (CEGL004192)—805 acres

18. Northeastern Coastal Plain Mixed Oak/Heath Forest (CEGL006269)—152 acres
19. Northeastern Modified Successional Forest (CEGL006599)—15 acres
20. Northeastern Old Field (CEGL006107)—904 acres
21. Northeastern Successional Shrubland (CEGL006451)—81 acres
22. Northern Bay Dune Shrubland (CEGL006295)—0.3 acres
23. Northern Coastal Plain/Piedmont Basic Mesic Hardwood Forest (CEGL006055)—8 acres
24. Overwash Dune Grassland (CEGL004097)—8 acres
25. Pond Pine Woodland (CEGL006470)—7 acres
26. Red Maple-Gum Successional Swamp Forest (CEGL006832)—296 acres
27. Red Maple-Seaside Alder Woodland (CEGL006317)—546 acres
28. Red Maple-Sweetgum Swamp (CEGL006110)—29 acres
29. Reed Tidal Marsh (CEGL004187)—623 acres
30. Successional Maritime Forest (CEGL006145)—100 acres
31. Successional Sweetgum Forest (CEGL007216)—60 acres
32. Successional Tuliptree Forest (CEGL007220)—16 acres
33. Swamp Cottonwood Coastal Plain Pond (CEGL006469)—1 acre
34. Twig-Rush Peat Mat (CEGL006467)—1 acre
35. Upland Switchgrass Vegetation (CEGL006616)—10 acres
36. Wax-myrtle Shrub Swamp (CEGL003840)—9 acres

Historical Vegetation Communities

1. Atlantic Coast Wild Rice Freshwater Tidal Marsh (CEGL004201)—2002 and 2007
2. Cattail Brackish Tidal Marsh (CEGL004201)—1937
3. Eastern Cattail Marsh (CEGL006153)—2002 and 2007
4. Freshwater Tidal Mixed High Marsh (CEGL006325)—1937
5. Interdune Switchgrass Brackish Depression (CEGL004129)—2002 and 2007
6. Mesohaline Seepage Marsh (CEGL006418)—1937
7. Northeastern Leafy Forb Marsh (CEGL006191)—2002 and 2007
8. Pickerelweed Tidal Marsh (CEGL004706)—1937
9. Prime Hook Freshwater Marsh (No NVC)—2002 and 2007
10. River Seedbox Marsh (CEGL006468)—2002

Land covers are those areas that are not vegetation communities but still cover the ground surface. In terms of sea level rise and loss of vegetation communities, saline water typologies (Marine Nearshore Polyhaline Water, Estuarine Coastal Polyhaline Water and Estuarine Coastal Mesohaline Water)were obviously the most important in terms of acreage of refuge land cover which significantly resulted in large vegetative changes in the refuge's impounded wetland habitats in Units II, III and IV.

The land covers include:

1. Agricultural Field—87 acres
2. Beach—18 acres
3. Estuarine Coastal Freshwater—78 acres
4. Estuarine Coastal Mesohaline Water—1,447
5. Estuarine Coastal Oligohaline Water—92 acres
6. Estuarine Coastal Polyhaline Water—1,091 acres
7. Farm Pond/Artificial Pond—4 acres
8. Freshwater Impoundment—0 acres
9. Impervious Surface— 16 acres

10. Marine Nearshore Polyhaline Water—36 acres
11. Modified Land—8 acres
12. Peat Mat—19 acres
13. Sabellaria Reef—0.1 acres
14. Sand—62 acres
15. Semi-impervious Surface—14 acres
16. Tidal Mudflat—742 acres
17. Transitional—269 acres

Historical Land Covers

1. Freshwater Impoundment—2002 and 2007
2. Mudflat-2002 and 2007

For the sake of this report and relevancy to planned restoration activities this AHMP will focus on the habitat responses documented in the mapping report for the following vegetation communities and summarized habitat conditions using land covers at the end of 2012 post Hurricane Irene but prior to Superstorm Sandy:

- Beachgrass-Panicgrass Dune Grassland
- Eastern Reed Marsh
- Overwash Dune Grassland
- Prime Hook Freshwater Marsh
- Red Maple-Seaside Alder Woodland
- Twig-Rush Peat Mat
- Estuarine Coastal Mesohaline Water
- Estuarine Coastal Polyhaline Water
- Marine Nearshore Polyhaline Water
- Sabellaria Reef

Beachgrass-Panicgrass Dune Grassland

This vegetation community on the refuge has demonstrated consistent landward migration to the west as evidenced by losses of this cover-type with subsequent gains in Marine Nearshore Polyhaline Water and Beach cover-types and also by conversion of former salt marsh to overwash flats. The beachgrass-panicgrass community representation in the photo below was taken in 2005 standing at the last house of Prime Hook Beach community, facing north. The dunes shown here were later breached by a severe 2009 November Nor'easter, Hurricane Irene and Superstorm Sandy. This vegetation community is dominated or co-dominated by American beachgrass (*Ammophila breviligulata*) and beachgrass (*Panicum amarum*). Other species present include seaside goldenrod (*Solidago sempervirens*), purple sandgrass (*Triplasis purpurea*), seaside spurge (*Chamaesyce polygonifolia*), and Gray's flatsedge (*Cyperus grayi*). No rare plants have been documented in this community but the Beach Tiger Beetle (*Cicindela hirticollis*) has been found in Unit I.

Losses in beachgrass-panicgrass dune grasslands and shoreline erosion have resulted in significant rates of change in the last 10 years (2002-2012) compared to much slower rates of vegetative changes and shoreline erosion during the 65 year time interval from 1937-2002. Most rapid changes have occurred in Unit II caused by multiple breaches of formerly intact dunelines. Habitat loss in this community has reverted to gains in Beach, Reed Tidal Marsh and Marine Nearshore Polyhaline Water, which are those waters that are part of the Delaware Bay and have now become incorporated into the refuge. Marine Near-shore Polyhaline Water was not present in 1937 and has since been introduced into the refuge as a result of natural shoreline transgression westward. It has steadily increased in acreage from the 1990s to present. This land cover is currently located in Unit I (14 acres) and Unit II (22 acres) which represents a total gain of 36 acres from 1937 to 2012. Of interesting note is the reversion of about 0.1 acre of this community type to Sabellaria Reef habitat in Unit II.

Overwash Dune Grassland

This herbaceous community is located in places where dunes have been overrun by high tides during extreme wind conditions and storm surges. Salt meadow cordgrass (*Spartina patens*) and sometimes three-square (*Schoenoplectus pungens*) or both are dominant on back dunes or overwash terraces. Total vegetation cover is very variable, ranging from 25% to 80% cover. Five acres in Unit I since 1937 have been reduced to 1 acre and in Unit II, three acres created post 1937 to 2002 have since been eliminated (zero acres) as one outcome of permanent multiple breaches. Phase I of 2014 restoration planning, design and construction will include the restoration of the Beachgrass-Panicgrass Dune Grassland vegetative community and also considerably expand overwash terraces in Unit II. Filling the breaches will result in also re-stablishing and expanding the Overwash Dune Grassland vegetative community.

Prime Hook Freshwater Marsh

This cover-type was used to describe the refuge's "impoundment years" (1982-2008) when R. Coxe conducted the first refuge vegetation cover mapping study project in 2005. It now serves as baseline community-type before breaching processes of dune habitats occurred. Prime Hook Freshwater marsh

was impossible to group into any known NVCS classification because widespread annual vegetative changes would alter wetland plant composition rapidly from season to season and year to year based on weather, rainfall patterns and dynamic water level management actions. The designation "Prime Hook Freshwater Marsh" was a composite of wetland cover-types based on dominant wetland communities that included:

- Atlantic Coast Wild Rice Marsh
- Eastern Cattail Marsh
- Brackish Meadow
- Pickerelweed Tidal Marsh
- Eastern Reed Marsh
- River Seedbox Marsh

Unit II started to lose emergent freshwater marsh sooner that Unit III due to the ephemeral breach created in Unit I in 2006. After that, high saline waters consistently intruded into Unit II via wide main OMWM channel feeding into culverts under Fowler Road. Losses in freshwater emergent marsh acreage of 1000 acres by 2012 transitioned into Estuarine Coastal Polyhaline Water, Tidal mudflat, Reed Tidal Marsh and Transitional Land cover-types. Unit III changes resulted in the loss of around 1200 acres of emergent freshwater marsh to Estuarine Coastal Mesohaline Water and Reed Tidal Marsh cover-types peppered with transitional land covers in adjacent upland areas.

Transitional Land Cover includes places on the refuge where land has been altered by salinity intrusion, flooding or both and contains dead or dying vegetation. These areas are in transition from one cover-type to another caused by salinity intrusion into formerly freshwater areas are depicted in the photos below. Extensive numerical analysis of net gains and losses of vegetation communities and land cover changes as outcomes of far-reaching shoreline migrations, inlet formations and sandy beach alterations can be examined in 545 paged vegetation mapping study report (Coxe - 2013).

Transitional Land Cover showing Dead and Dying Trees between Marsh and Beach Communities in Unit II

Dying and Dead Red Maple-Seaside Alder Woodland along Prime Hook Creek

Red Maple-Seaside Alder Woodland

This vegetation community is located in the upper reaches of the Prime Hook Creek within the former Unit III impoundment. It is mostly dominated by red maple (*Acer Rubrum*) in the canopy with dense stands of seaside alder (*Alnus maritima)* in the understory. It is an especially unique vegetation community in Delaware as the seaside alder is rare in the state (S2) and globally (G1). The shrub layer is composed of sweet pepperbush (*Clethra alnifolia*), southern bayberry (*Morella cerifera*), buttonbush (*Cephalanthus*). Common herbaceous species include the royal fern (*Osmunda regalis), northern St. John's Wort (Triadenum virginicum*), cardinal flower (*Lobelia cardinalis*), weak stellate sedge (*Carex seorsa*), three-way sedge (*Dulichium arundinaceum*), and water-pepper (*Polygonum hydropiperoides*).

This plant community was just developing in the upper reaches of Prime Hook creek in 1937. During the impoundment years the community matured with the stabilization of non-tidal freshwater regime. After breach formations in Unit II more saline waters have entered the Unit III aquatic system causing seaside alder population declines which has zero tolerance to salinity. To a lesser extent red maple declines are also evident which has little tolerance (< 5 ppt) to salinity.

Twig-Rush Peat Mat

Located in Unit III several peat bog communities located in Fleetwood, Goose and Flaxhole ponds are dominated by twig-rush (*Cladium mariscoides*) and associated with pink based yellow-eyed grass (*Xyris difformis*), Virginia meadow beauty (*Rhexia Virginia-S2)*, sessile leaved bugleweed (*Lycopus amplectens-S2)*, Virginia chain fern (*Woodwardia virginica*), small-fruited tick seed (*Bidens mitis-S2*), browned-fruited rush (*Juncus pelocarpus-S2*), whorled pennywort (*Hydrocotyle verticillata-S2*), and roundleaf sundew (*Drosera rotundifolia*). Woody species such as seaside alder, sweet pepperbush and meadow-sweet spiraea are also sparsely scattered around within this vegetation community. These peat mat communities were once more plentiful in 1937 within refuge boundaries (117 acres) but have steadily declined to 23 acres by 2002 and reduced to 19 acres by 2012. Most losses are due to salinity intrusion. These vegetation communities are very diverse and contain a considerable number of state rare wetland plants which are listed below:

Scientific Name	Common Name	Rarity State Rank
Andropogon glomeratus var. hirsutior	Bushy Bluestem	S1
Bartonia paniculata	Twining Bartonia	S2
Bidens coronate	Tickseed Sunflower	S3
Cyperus diandrus	Umbrella flatsedge	S1
Eleocharis robbinssi	Robbins spikerush	S3
Eriocaulon compressum	Flattened Pipewort	S2
E. decangulare	Ten-angle Pipewort	S1
E. parkeri	Parker's Pipewort	S2
Eriophorum virginicum	Twany Cotton-grass Sedge	S1
Fuirena pumila	Dwarf Umbrella-sedge	S3
F. squarrosa	Hairy Umbrella-sedge	S2
Pogonia ophioglossoides	Rose Pogonia	S2
Rhynchospora alba	White Beakrush	S2
R. scirpoides	Long-beaked Beakrush	S2
Sagittaria engelmanniana	Engelmann's arrowhead	S2
S. graminea	Grrass-leaf arrowhead	S2
Sarracenia purpurea	Purple Pitcher-plant	S2
Smilax walteri	Walter's Greenbrier	S3
Spiranthes cernua	Nodding Ladies-tresses	S3
Utricularis fibrosa	Fibrous Bladderwort	S2
U. juncea	Southern Bladderwort	S2

The previous cover-type discussion focused on vegetation community covers. The next description includes land covers that are not vegetation communities but still cover ground surface. In terms of sea level rise impacts and loss of vegetation communities, water obviously is the most important cover-type

change experienced within the refuge's impounded and formerly impounded areas within Units II and III. Also of interesting note is the creeping appearance of Sabellerid communities building over old, formerly submerged remnant peat marsh.

Marine Nearshore Polyhaline Water

The CMECS (Coastal and Marine Ecological Classification Standard) land cover includes those waters from 25 to < 30 ppt salinity that are part of Delaware Bay but are now located within the refuge boundaries. Marine Nearshore Polyhaline water were not present in 1937 on refuge lands but has since creeped into refuge boundaries because of natural west-ward transgression of the Bay shoreline. It has steadily increased in acreage through the years and is currently located in Units I and II for a total gain of 36 acres from 1937 to 2012.

Estuarine Coastal Polyhaline Water

This land cover is defined by tidal bodies of water near the coast that is between 18 to 30 ppt salinity. During 1937 it was present in all the management units. It remained present in Unit I but was not present in Unit II or III until after 2007. In total this cover-type gained about 1,007 acres from 1937 to 2012 mostly in Unit II.

Estuarine Coastal Mesohaline Water

This cover-type represents tidal bodies of water near the coast that are between 5 and 18 ppt salinity and accounts for covering 1,446 acres in Unit II and III but mostly in Unit III.

Sabellaria Reef

Sabellaria Reef includes substrate that is composed of mound-like aggregations of living and non-living materials (reef) created by tubeworms (Sabellarids). Conditions in the lower half of the Delaware Bay are perfect for *Sabellaria vulgaris* worms that build elaborate sand habitats for fish and other aquatic life during high tide. Areas along the Delaware Bay shoreline from Port Mahon to Broadkill Beach are the only known places in the world where *S. vulgaris* occur. Sabellaria Reef cover-type included 0.1 acre in Unit II map by the end of 2012. As of 2014 post-sandy conditions have broken up sabellaria reef aggregates on the refuge and viable colonies no longer exist.

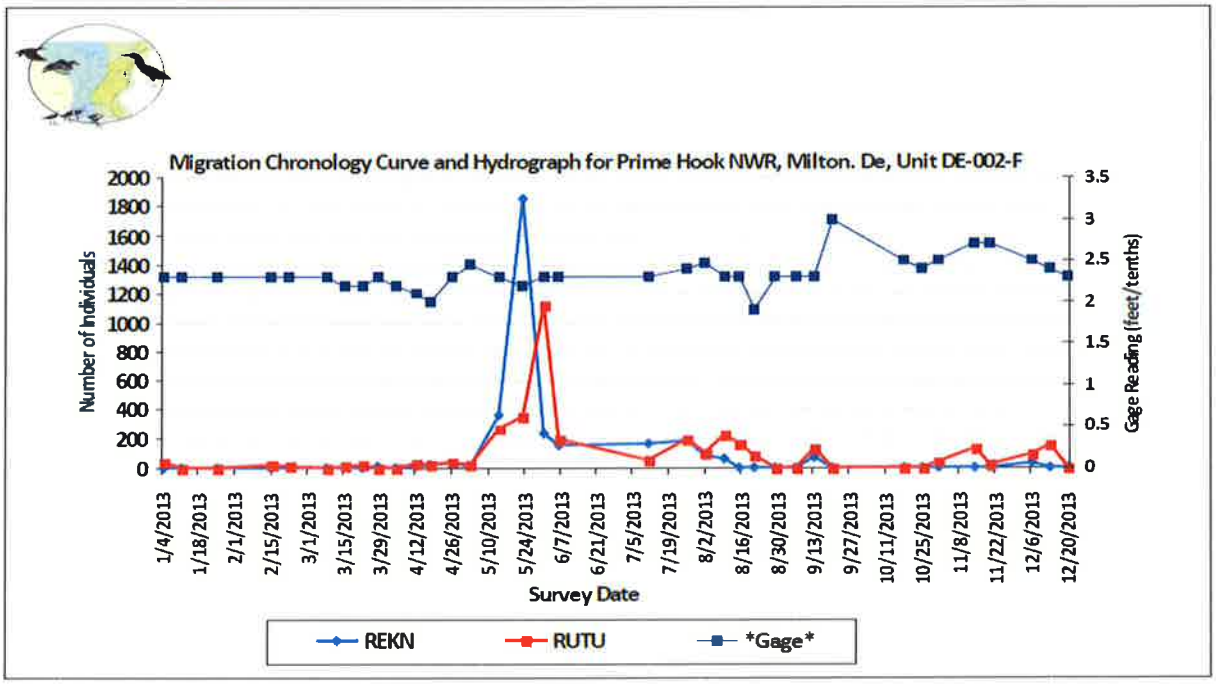
IV. Wildlife Responses

IWMM survey data serves as a key measure of refuge wildlife responses to abiotic and habitat conditions and examines the relationship of migratory bird use (waterfowl, shorebird & waders) across the six survey sites listed in Table 1 under the section describing habitat responses. Birds were counted by direct observation using 20-45X spotting scope and 8x10 binoculars at weekly or biweekly intervals. Whole area counts make use of a small number of vantage points around the perimeter of each census area that were used to count birds directly. The census areas are representative of the refuge's former impounded wetlands in Units II, III and IV.

IWMM survey data can be used to measure migration chronology, species composition, abundance, distribution, and bird-use trends throughout the refuge's traditional impounded marsh complex. IWMM bird survey data can also provide water-bird use comparisons for pre and post marsh restoration work. Migration chronology data can also be used to demonstrate the dynamics of migration for specific bird

species as they pulse through refuge habitats for any given year or between years. For example, see Chronology of Use Chart for Red Knots and Ruddy Turnstones below. A comparison of chronology of use graph between redknots and ruddy turnstones showed that red knots peaked at around 1900 birds during the spring migration in 2013 and then dropped off to around 200 birds for several weeks during the fall shorebird migration whereas spring migrant ruddy turnstones peaked at about 1100 birds during the first week of June and then came through again in smaller numbers throughout the fall migration until the first week of December.

FIGURE 12. Chronology of Use for Red Knots and Ruddy Turnstones for Census Unit DE_002F in 2013



Bird-Use Days

Bird-use days (UDs) can provide an assessment of how individual species or select guilds utilize different survey areas. Use-days can be estimated from the IWMM data set. A bird-use day is defined as one bird or guild spending 24 hours within the census area during a specific time range. The IWMM program uses a trapezoid-base integration approach to estimate bird-use days for a calculated time interval. For example calculated waterfowl use days and shorebird use days for calendar year 2013, within refuge impounded habitats provided roughly 10 million waterfowl use-days (9,754,577 days) compared to 1.4 million shorebird use-days (1,419,794). What a difference five decades makes. When the refuge was first established in 1963, historic duck use-day objectives were set for 3.5 million days and 1 million use-days for Canada geese, for a total of 4.5 million waterfowl use-days. There were also fervent hopes that the refuge would improve the declining population numbers of snow goose, by providing more feeding and

roosting areas for the "rare" snow goose as winter residents. During the 1960s Prime Hook snow goose numbers only peaked at 10 birds for the entire fall and wintering periods.

Today, snow geese dominate refuge habitats as fall and winter residents of the refuge. The IWMM calculates waterfowl or shorebird use-days for each of the six census units based on the number of respective waterfowl species (ducks and geese) and/or all shorebird species recorded in each unit. The program then adds use-day calculations for each census unit and totals them for a given time interval. Comparing waterfowl versus shorebird use-day distribution data between census units the southern portion if Unit III (DE_002A) was most important for waterfowl while the northern portion of Unit II (DE_002F) held the most significance for shorebirds.

PRIME HOOK NWR WATERFOWL AND SHOREBIRD USE-DAYS FOR IWMM CENSUS-UNITS FOR 2013				
Census Unit	**Waterfowl UDs**	**Waterfowl UDs/Acre**	**Shorebird UDs**	**Shorebird UDs/Acre**
DE_002A	4,082,091	58,315	305,695	4,367
DE_002B	2,238,290	37,304	297,487	4,958
DE_002C	944,911	15,748	86,838	1,447
DE_002D	1,704,493	8,118	86,582	412
DE_002E	679,013	4,526	157,105	1,047
DE_002F	105,779	3,525	486,086	16,202

Waterfowl use-day calculations are greatly inflated by high snow geese numbers that peaked at over 90,000 birds in 2013. However, even those numbers were low compared to peak snow goose numbers for 2012 (> 150,000 birds). IWMM ground-survey snow geese census trends also tracked similarly with state-wide aerial survey numbers conducted by the Delaware waterfowl biologist. Peak numbers of 131,052 reflected high numbers of snow geese in 2012 for the state were parallel to IWMM peaks of 150,000 birds. Much lower snow goose numbers 60,000 birds (state aerial survey) for 2013 compared to 80,000 $^{+}$ snow geese from IWMM survey data for the same time period as depicted in figures 14 and 15.

FiGURE 14 Chronology of Use for Snow Geese for all IWMM Census Units for 2013

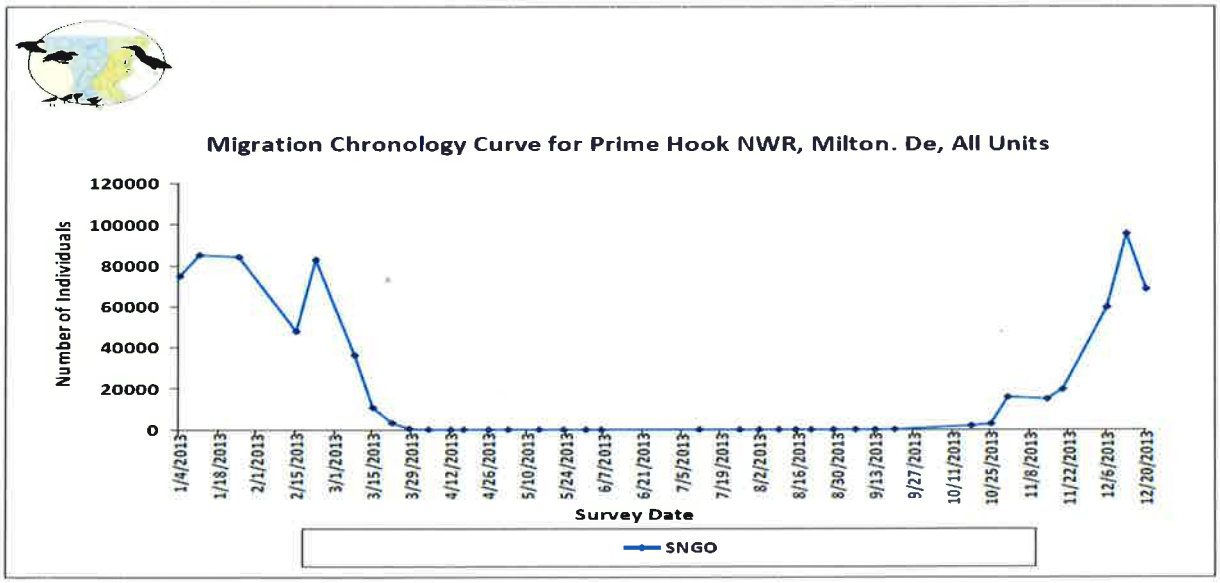
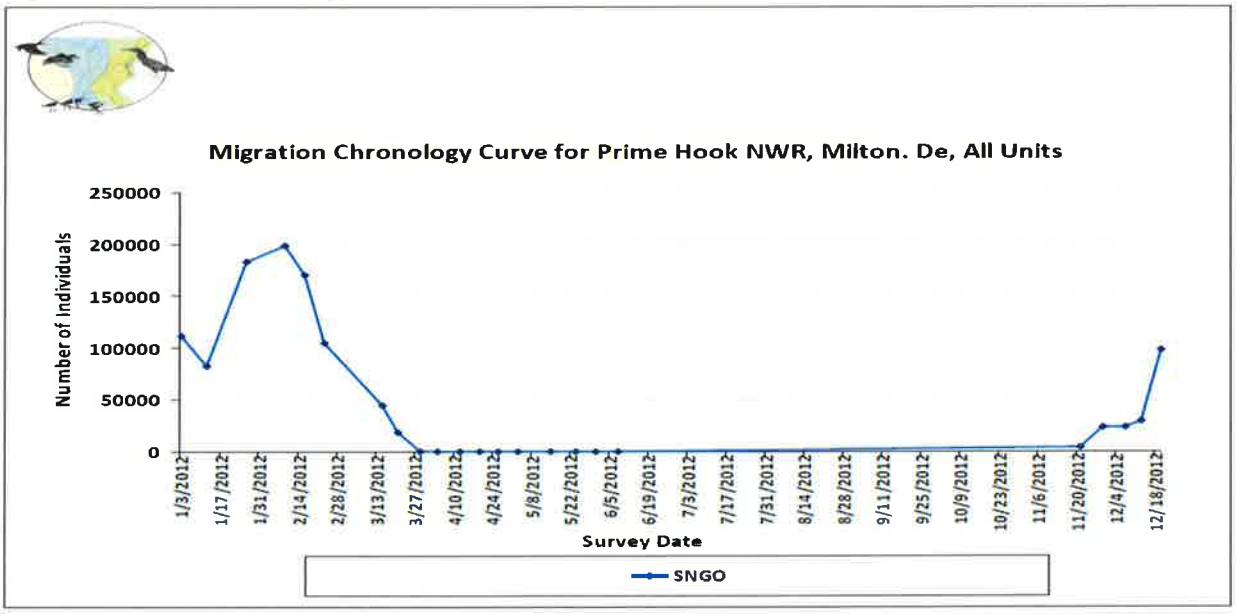


Figure 15. Chronology of Use for Snow Geese for all IWMM Census Units for 2012



IWMM bird data can provide trends in patterns of bird-use, bird density, water-bird phenology, species composition and dominant species. Further analysis of bird use of the refuge's habitats focus on the most abundant or dominant water-bird species recorded in each of the six survey sites and compared across three years of data (2011, 2012 and 2013). Percent total = (number of particular species/total number of birds) x 100. The highest numbers of birds recorded across all units during 3-year comparisons occurred in 2012, attributed to greatest numbers of snow geese compared to 2013 and 2011, respectively. In 2011 census area DE_002A, which covers the south western portion of Unit III, nine dominant water-bird species account for 92% of total bird numbers and 36 species accounted for the remaining 8%. In table below CY 2012 showed a significant increase in bird totals from 151,404 to

563,372 birds, again attributed to higher snow goose numbers. In 2012, 92% bird use was attributed to five dominant species and in 2013 87% bird use was distributed among four dominant species.

DE_002A	2011	DE_002A	2012	De_002A	2013
Dominant Species	**% Total**	**Dominant Species**	**% Total**	**Dominant Species**	**% Total**
Snow Goose	63	Snow Goose	79	Snow Goose	72
Green-winged Teal	7	Canada Goose	4	Canada Goose	7
Northern Pintail	7	Green-winged Teal	3	Green-winged Teal	5
Semipalmated Sdpr	6	Semipalmated Sdpr	2	Semipalmated Sdpr	3
Dunlin	3	Northern Pintail	2	Other = 42 species	13
Short-billed Dowitcher	2	Other = 38 species	8		
Greater Yellowlegs	2				
American Black Duck	1				
Canada Goose	1				
Other = 36 species	8				
Total Number	151,404	**Total Number**	563,372	**Total Number**	500,583

In tables below, snow goose dominance continued in all the other census units with varying species composition of remaining dominant waterfowl or shorebird species for each unit. A total of 82 water-bird species were recorded from 2011 to 2013. For a complete species list of water-birds mentioned in the "other" category and phenology mapping derived from refuge IWMM chronology of use data see Appendix D.

DE_002B	2011	DE_002B	2012	DE_002B	2013
Dominant Species	**% Total**	**Dominant Species**	**% Total**	**Dominant Species**	**% Total**
Snow Goose	42	Snow Goose	83	Snow Goose	55
Semipalmated Sdpr	14	Green-winged Teal	4	Canada Goose	11
Green-winged Teal	10	Semipalmated Sdpr	4	Green-winged Teal	7
Northern Pintail	7	Canada Goose	3	Semipalmated Sdpr	5
Dunlin	5	Northern Pintail	1	Other = 44 species	22
Other = 31 species	22	Dunlin	1		
		Other = 33 species	4		
Total Number	126,090	**Total Number**	454,126	**Total Number**	269,822
DE_002C	**2011**	**DE_002C**	**2012**	**DE_002C**	**2013**
Dominant Species	**% Total**	**Dominant Species**	**% Total**	**Dominant Species**	**% Total**
Snow Goose	53	Snow Goose	71	Snow Goose	63
Green-winged Teal	11	Canada Goose	9	Canada Goose	10
Semipalmated Sdpr	10	Green-winged Teal	6	Green-winged Teal	6
Northern Pintail	5	Northern Shoveler	4	American Black Duck	3
Western Sandpiper	5	Northern Pintail	3	Semiplamated Sdpr	3
Canada Goose	2	Dunlin	3	Northern Shoveler	2
Semipalmated Plover	2	American Black Duck	2	Blue-winged Teal	2
Short-billed Dowitcher	2	Other = 26 species	2	Other = 29 species	10
American Black Duck	2				
Dunlin	1				
Other = 20 species	7				
Total Number	62,323	**Total Number**	86,521	**Total Number**	115,733

DE_002D 2011	
Dominant Species	**% Total**
Snow Goose	54
Green-winged Teal	18
Northern Pintail	5
Semipalmated Sdpr	4
Greater Yellowlegs	3
American Black Duck	2
Dunlin	2
Other = 26 species	12
Total Number	**51,976**

DE_002D 2012	
Dominant Species	**% Total**
Snow Goose	74
Canada Goose	10
Green-winged Teal	4
Greater Yellowlegs	2
American Avocet	1
Northern Pintail	1
American Widgeon	1
Northern Shoveler	1
Dunlin	1
Other = 29 species	
Total Number	**153,016**

DE_002D 2013	
Dominant Species	**% Total**
Snow Goose	67
Canada Goose	5
Green-winged Teal	5
Snowy Egret	4
Northern Pintail	2
American Black Duck	2
Northern Shoveler	2
Dunlin	2
Blue-winged Teal	1
Other = 30 species	10
Total Number	**103,000**

DE_002E 2011	
Dominant Species	**% Total**
Snow Goose	65
Northern Pintail	7
Green-winged Teal	6
Semipalmated Sdpr	4
Greater Yellowlegs	3
Dunlin	3
Other = 30 species	12
Total Number	**68,047**

De_002E 2012	
Dominant Species	**% Total**
Snow Goose	74
Canada Goose	10
Green-winged teal	3
Northern Pintail	2
Northern Shoveler	2
American Widgeon	2
Greater Yellowlegs	2
American Black Duck	1
Other = 36 species	8
Total Number	**186,442**

DE_002E	
Dominant Species	**% Total**
Snow Goose	21
Canada Goose	15
Green-winged teal	10
Dunlin	8
Northern Shoveler	6
American Black Duck	4
Snowy Egret	4
Semipalmated Sdpr	3
Other – 39 species	29
Total Number	**92,082**

DE_002F 2011	
Dominant Species	**% Total**
Snow Goose	36
Dunlin	15
Semipalmated Sdpr	8
Ruddy Turnstone	7
Short-billed Dowitcher	5
Sanderling	5
Red Knot	4
Green-winged Teal	3
DCCO*	3
American Black Duck	2
Black Skimmer	1
Other = 36 species	11
Total Number	**53,125**

DE_002F 2012	
Dominant Species	**%Total**
Snow Goose	60
Dunlin	9
Semipalmated Sdpr	4
Canada Goose	4
American Black Duck	3
Red Knot	3
DCCO	2
Short-billed Dowitcher	2
Sanderling	2
Yellowlegs	2
Green-winged Teal	1
Ruddy Turnstone	1
Black-bellied Plover	1
Black Skimmer	1
Other = 30 species	5
Total Number	**64,567**

DE_002F 2013	
Dominant Species	**% Total**
Semipalmated Sdpr	30
Dunlin	10
Ruddy Turnstone	6
Red Knot	5
Sanderling	5
American Black Duck	5
Black Skimmer	4
DCCO	4
Greater Yellowlegs	4
Western sandpiper	4
Snow Goose	3
Green-winged Teal	2
Other = 43 species	18
Total Number	**59,201**

* DCCO = Double-crested Cormorant

Shorebirds were the most abundant group of water-birds in census area DE_002F which is located in the breached area within Unit II's barrier island habitat. Unsurprisingly it experiences the greatest shorebird use (both density and diversity of species). This is the prime area where red knots, ruddy turnstones, sanderlings, semipalmated sandpipers, short-billed dowitchers and dunlin congregate during the spring shorebird migration. For management implications any areas within the impounded complex that can still experience effects from water level manipulations to create moist soil and shallow water areas up to about 10 cm in depth are optimal. As demonstrated from 2013 shorebird survey numbers, when water levels can be drawn down to correspond to spring migrant arrivals, annual shorebird use is numbered at greater than million use-days per year, supporting the existing designation of the Delaware Bay and the refuge as a site of Western Hemispheric importance to shorebirds, as well as a major Atlantic Flyway wintering and stop-over site for waterfowl.

V. Unmet Habitat Needs

Upland Habitat Management

In Section III the summarized results of vegetation mapping project conducted in 2013 indicated that Northeastern Old Field (904 acres) was the largest vegetation community mapped within Units I, II and III. This did not include Unit IV where an additional 100 plus acres of Northeastern Old Field habitats are also located. The biological integrity and diversity of open field habitats are very important for a wide host of focal species identified in the CCP and HMP that have the greatest conservation need across state boundaries and also from a northeast regional landscape perspective.

"Old Fields" is a broad term that applies to many open, transitional habitats transitioning from field to forest but in general these areas are dominated by forbs, grasses, shrubs and small trees. The vegetation make-up of these habitats is variable based on the length of time since past disturbance, management history and other factors. Transitional habitats have been identified in the HMP where specific transitional habitat management goals and objectives to maintain and enhance the BIDEH of these open upland areas for nesting and migrating landbirds and other bird species in the spring, summer and fall.

Recent "Migratory Radar Studies" (Buler & Dawson 2012) have demonstrated the refuge is a critical "Hot Spot" for migratory passerines, especially fall migrants that are funneled from northern breeding grounds across the bay and use refuge upland and forested wetland habitats. These refuge habitats contain significant food resources providing important fueling stop-over areas for significant numbers of passerines on route to more southern wintering grounds in Central and South America.

Habitat management treatments of these "Old Fields" have been extensively described in the final CCP and HMP as to how we should conserve and enhance the biological integrity of upland soils, plant and wildlife diversity and the environmental health of old field habitats to conserve and manage for all the identified targeted focal species associated with these areas. Since 2005 we have done minimal habitat management of these areas. Minimal treatments only included mowing Old Fields as a "holding pattern" to set back succession until finalization of HMP.

We are now in a position to be able to implement more diverse upland habitat management strategies and Old Field treatment prescriptions identified in HMP that serve the purposes of improving upland soil

health and native vegetation diversity with proactive management techniques that go beyond mowing to set back succession. These upland management techniques also increase native forb and insect diversity and insect pollinator populations in old fields and help to create a diverse mosaic of micro-habitats. In addition to mowing, maintaining and enhancing the BIDEH of early successional habitats is best accomplished by rotational burning, disking, cultivation and/or chopping undesirable woody vegetation and other cultural techniques used to expose bare soil and improve soil structure and composition. Imposing a shallow disking-disturbance regime scarifies surface of upland soils and stimulates the seed banks of native forbs and other desirable vegetation.

Burning, shallow soil disking and cultivation to expose bare soil are techniques described in HMP to help suppress undesirable vegetation (invasive plants and woody vegetation) instead of herbiciding and are more efficient than just mowing. Inter-seeding of selected disked areas with legumes (clovers) and forbs in existing native grass stands also enhances soil health and improves nutrient and soil moisture availability, smothers weeds and provides increased carrying capacity for targeted wildlife and insect pollinator populations.

It is preferable to rely on cultural techniques over chronic chemical use to suppress woody encroachment and improve soil health of early successional habitats. Creating short-rotation niches using disked areas planted with clover and native wildflower mixes are examples of alternative techniques that serve to control weeds and woody vegetation, reduces or eliminates the reliance of herbicides, greatly increases plant and insect diversity and subsequent wildlife use of targeted focal species identified in habitat goals and objective for transitional areas. Cultural techniques used to create "old field" management outcomes also provide very aesthetically pleasing habitat viewing (beatification) and improve wildlife observation opportunities by visitors especially in the headquarters area.

More specific old field and water level management "prescriptions" are described in the next section that will include specific locations, timing, interval and intensity of habitat management actions.

Wetland Habitats

A large salt marsh restoration project including Units II and III may begin as early as the fall of 2014 and/or winter of 2015. CY 2014 will mostly be spent designing the project, preparing a supplemental EIS, and obtaining numerous permits and completing a Restoration Monitoring Plan.

From prior marsh platform elevation and sedimentation studies using radiometric analysis of vibra-core sampling of marsh soils, we have learned that impounding the coastal estuarine wetland areas of Units II and III has had a profoundly negative impact on the environmental health of these systems. After soil core sampling taken from all four units, and other Delaware Bay reference salt marsh wetlands, radionuclide geochronology of soils and accretion rate analysis revealed Unit II and to a lesser extent Unit III were not able to evolve and keep up with local sea level rise rates during the past 50 - 100 years (Sommerfield 2012).

Marshes accrete vertically in two ways: (1) by trapping sediment delivered by tidal waters and storms and (2) through the conservation and retention of below ground production (roots and rhizomes) in the form of peat. The established salt marsh habitats in Units I and IV were able to accrete above local sea

level rise values. However impounded wetland areas in Units II and III were not able to keep up and when breaches introduced high saline waters to areas dominated by brackish and freshwater annual plants, conditions were ripe that created a rapid onset of marsh loss related to plant stress of below ground biomass.

Planned salt marsh restoration seeks to overcome marsh loss and functional degradation of Units II and III. We will soon be in the design stage of the project which will then be followed by two phases of wetland restoration construction. The first phase of construction will repair the shoreline. The second phase will involve drainage improvement of both units by re-excavating higher order tidal creeks branching off from enlarged and deepened main conveyance channels. We believe we can restore tidal flow and salt marsh wetland function without creating or enhancing mosquito breeding habitat.

Phase II construction will increase tidal re-circulation and improve water turnover rates, expand water flow and drainage and improve water quality throughout Units II and III. Restoration design and maintenance principles will avoid the accumulation of stagnant, standing waters, provide physical and biological systems for mosquito control and greatly improve habitat for fish.

A specific Salt Marsh Restoration Monitoring Plan will soon be completed and then Pre-Restoration Project Monitoring Data will be collected starting this summer. Wetland Restoration Project Construction and Monitoring designs will revolve around the following habitat management objectives:

1. Restore salt marsh platforms or surface areas and tidal regimes
2. Conservation and enhancement of quality fish habitat and healthy fish populations
3. Restoration of native salt marsh vegetation in Unit II with a component of 65% vegetative cover to 35% open water; and creating hemi-marsh conditions in Unit III (50% vegetative cover to 50% open water)
4. Create physical and biological conditions that control salt marsh mosquito production
5. Control Invasive Plants

VI. Management Strategy Prescriptions

In this section upland and wetland management actions for the CY 2014 are listed. These actions have already been described as approved management strategy prescriptions in the HMP and implemented in the AHWP.

Upland Management Prescriptions

The following prescription codes will be used as old field treatments in specific old field prescription table for CY 2014 listed below.

[R_X]: Set back succession by reducing/eliminating competition from woody plants; improve soil fertility; keep undesirable plants from encroaching upon grassland habitats; remove exotic species; expose and create certain percentage of bare soil.

[**Culture**]: This code represents cultural techniques like shallow disking and selective plantings of legume for soil amendments to improve soil structure, fertility and soil moisture availability, pollinator

enhancement, control/discourage woody vegetation encroachment, weed suppression, beautification and enhancing wildlife use. Legumes = clover species that grow best as mixtures with native gasses and/or forbs (wildflowers). Spring plantings = Early April- mid May with Alsike (ladino) clover mix and Early Fall = Crimson Clover mix.

[**Cut**]: Cut code include mowing and brush hogging where needed and prescribed. Cur prescriptions should not take place within an entire field at the same time. Each field should be divided into sub-sections that will be treated in rotation to maximize micro-diversity within each field environment. This technique creates habitat of different structure and types to target a greater number of focal wildlife species identified in CCP and HMP. Annual mowing or brush hogging of entire stands should be discouraged because it greatly decreases plant diversity and reduces residual cover available for the following nesting season.

Two mowing techniques could be used on an annual basis that will increase structural and native plant diversity:

1. [Fields > 10 acres]: Mow after August 1st to protect ground nesting wildlife and allow residual growth. Mow no more than 1/3 to ½ of field. Rotate mowed areas each year. If native warm season grasses are present (switchgrass, bushy bluestem, little bluestem foxtail barley, purple-top fluffy grass, etc) mow no shorter than 6 – inches. Where turtles, snakes or other reptiles are present, mow after October 1st.
2. [Field < 10 acres]: A second option for mowing technique is "spring strip mowing" to be done March 15-April 15 to encourage vegetative diversity, without negatively impacting spring bird nesting activities or loss of fall food plants.

Problem trees within "designated grassland maintenance fields" may also have to be cut, trimmed or girdled or treated with herbicide. Cut trees can be used to construct brush piles. Tree cutting and other tree removal techniques should also take place outside of the primary nesting season.

Prescribed fire and cultural techniques also helps to remove excess litter accumulation, which can reduce the quality of grassland habitats and create more "exposed bare soil" component producing a more desirable mosaic of micro-habitat types for upland wildlife species.

[Re-Forestation]: Re-establishment of forest cover, either naturally (by natural seeding or root suckers) or artificially (by direct seeding or planting). During late winter of 2014 artificial forestation will occur in designated old fields at a density of ~ 435 seedlings per acre with the following species:

- Black Oak, *(Quercus velutina)*
- Northern red oak, *(Q. rubra)*
- Southern red oak, (*Q. falcata*)
- Swamp chestnut oak, (*Q. michauxii*)
- White oak, (*Q. alba*)
- Willow oak, (*Q. phellos*)
- Water oak, (*Q. nigra*)

- Persimmon, (*Diospyros virginiana*)

With the exception of "strip mowing" all other mowing, brush hogging, cultural techniques (disking, plantings, tree cutting, etc) re-forestation and prescribed burning will generally occur outside of the primary nesting season (April 15 – August 1st).

[**Wet/Restore**]: **Moist-soil small impounded wetland restoration:** 2014/2015 restore ~150 acres of moist-soil brackish wetland by plugging ditch(es) depending on site topography (grading/contouring areas and fitting one drainage ditch with inexpensive agri-drain PVC in-line log structure to manage water levels on site for shorebirds, waterfowl and waders.

All "Old Fields" will also be annually monitored for noxious and invasive plants and treated as needed any time during the growing season using early detection, rapid response herbiciding actions.

Old Field Treatment Prescriptions for CY 2014	
Location	Treatment Prescription
Unit I Field 108b: 10 acres	**CUT**: Strip Mow in Summer (After August 1st)
Field 111: 20 acres	**CUT**: Mow ½ Field in 2014 & Alternate Mow Sections in 2015
Unit II Field 201: 62 acres	**WET/RESTORE**
Field 202: 58 acres	**WET/RESTORE**
Field 204: 10 acres	**CUT**: Strip Mow in Summer (After August 1st)
Field 205: 17 acres	**CUT**: Strip Mow in Summer
Field 206: 9 acres	**CUT**: Strip Mow in Summer
Field 207: 8 acres	**CUT**: Strip Mow in Summer
Field 208: 25 acres	**CUT**: Mow ½ Field in 2014/Other Half in 2015
Unit III	
Field 330: 13 acres	(Amoeba field): Treat Noxious Weeds as Needed-Do Not Mow
Field 331: 6 acres	Do Not Mow: Allow natural Succession to trees to eventually shade out noxious weeds.
Field 338: 7 acres	Do Not Mow. Treat noxious weeds as needed.
Field 301: 18 acres	**CUT**: Strip Mow
Field 318: 20 acres	**CULTIVATE**: Divide in 1/3s; Disk & Plant Alsike clover with wildflower mix in spring
Field 321: 40 acres	**CULTIVATE**: Divide in 1/3s; Disk & Plant crimson clover with forb/native grasses mix in fall
Field 322: 11 acres	**CUT**: Mow ½ in 2014 & Second Half in 2015
Field 323: 16 acres	**CUT**: Mow ½ in 2014 & Second Half in 2015
Field 332: 50 acres	**RE-FORESTATION**
Field 350/351/352/353/356: { R_x }	**RX:** ~ 106 acres Fields 350→ 356 in early 2014
Field 357: 35 acres	**RE-FORESTATION**
Unit IV	
Field 401: 7 acres	**RX**: All Fields in Island Farm DO NOT MOW in 2014 in preparation for Prescribed Burning immediately after hunting season [Early 2015 Winter Burn]

Field 402: 8 acres	RX
Field 403: 12 acres	RX
Field 404: 6 acres	RX
Field 408: 8 acres	RX
Field 409: 22 acres	RX
Field 411: 10 acres	RX
Field 412: OMNI Tower Field	Exception Mow not R_x

Barrier Island Nesting Bird Protection

Post before March 1st beach areas in Units I and II to protect beach nesting and migrating shorebird species at critical nesting and migrating times from human disturbance and dogs running at large over dune and overwash habitats. Eliminate dog use and human disturbance through beach closures, active law enforcement patrolling and public education. Seasonally protect beach berm, wrack-lines, associated dune edge and overwash habitats from human and canine disturbance to safeguard state and federally listed breeding and migrating shorebird species by establishing and enforcing nesting and migratory feeding and roosting area closures from March 1st to September 1st as described in final CCP. Use high-visibility law enforcement patrols to implement beach closures. These shorebird conservation activities are essential to achieving the specific elements list in Habitat Management Goal 1 and Objective 1.1 (See Appendix A).

Wetland Management Prescriptions: Pre-Restoration Wetland Level Management Strategies and *Phragmites* Control

Practice salinity management and moist-soil management to a limited extent in Unit III using similar water level regimes used in 2013 that were very successful. Performing slow drawdowns in spring and then slowing re-flooding marsh soils from the end of June to September 1st can achieve a limited form of positive brackish moist-soil vegetation response and reduce/eliminate extreme desiccation and oxidation of marsh soils during the summer months. Performing a slow early spring to early summer drawdown and then putting logs back into the structure by late June to slowly increase water levels from captured rain events has the following advantages:

- Minimize salinity extremes in Unit III water column during the growing season
- Promote Positive Vegetation Response of annual and perennial wetland plants
- Prevent fish/invertebrate kills by maintaining higher water levels in July and August that aid to lower water temperatures and maintain higher DO levels
- Create conditions that decrease potential avian botulism outbreaks
- Reduce sulfide toxicity of extant stands of *Spartina patens* in Unit III
- Encourage the development and expansion of annual wetland plants such as bulrush, spikerush, fall panicum and wild millet, by maintaining water column salinities less than 10 ppt during the growing season
- Improve sediment retention in Unit III by effecting slow drawdown rates

Maintaining higher water levels during peak heat of summer months in partially impounded wetland environment in Unit III has shown to be a good short-term remedy to improve water quality. This strategy also helps to prevent fish-kills and die-offs of aquatic invertebrates whose decomposing

carcasses could then potentially become focal centers for the growth of *Clostridium* botulinum (USFWS-1987). Timing and duration of drawdown and re-flood prescriptions are listed in table on next page.

Sulfides are generally stored as pyrites (FeS_2) in estuarine sediments and can oxidize to sulfuric acid under high saline conditions. Tidal salt marsh vegetation is less susceptible to such sulfide stress due to greater tidal flushing. However, diked marsh soils in Unit III, if exposed to air and high saline conditions for prolonged periods, can cause sulfides to re-oxidize to sulfuric acid and rapidly decrease marsh soil pH that eliminates or discourages wetland plant growth. These conditions can be mitigated for by maintaining higher water levels in Unit III during summer months of July and August to reduce sulfide stress to vegetation in Unit III by:

1.) Helping push back salt water intrusion from Unit II culverts by holding higher water levels in Unit III

2.) Reducing the potential of sulfide toxicity to *Spartina patens* and annual brackish wetland plants whose salinity tolerances for optimal growth are $\leq$ 10 ppt. Preventing marsh soils from drying out in the southern portion of Unit III during droughty weather conditions, also reduces sulfide stress to emergent brackish marsh vegetation.

For the most part only conduct *Phragmites* control in high use public areas or certain upland areas as needed. The decision to not conduct any *Phragmites* spraying in impounded or other wetland areas was suggested by wetland management experts during a Technical Wetland Restoration Workshop held at the refuge in 2012. To support this notion accretion rates estimated for individual wetland plants in barrier island geomorphic setttings have been determined by ^{210}Pb dating techniques (Dr. Michael Kearny-U Md). Dr. Kearny's work has shown the varying accretion rates for the top three accreting wetland plants which include: 1) *Phragmites australis* = 10 mm/year; 2) *Spartina alterniflora* = 2.0 mm/year; and 3) *S. patens* = 1.5 mm/year. These values provide a sense of the differential accretion capabilities for trapping sediments of some dominant wetland plants.

Unit III Water Level Prescriptions at Petersfield WCS for 2014

Date	Proposed Water Level CY 2014	Water Level CY 2013	Salinity (ppt) CY 2013
01-01-2014	2.80 feet (msl) = Full Pool Level	2.70	10
01-15-2014	2.80	2.70	10
01-31-2014	2.80	2.70	10
02-15-2014	2.70	2.40	5
02-28-2014	2.70	2.70	6
03-15-2014	2.60	2.80	8
03-31-2014	2.60	2.70	10
04-15-2014	2.60	2.60	5
04-30-2014	2.50	2.70	10
05-15-2014	2.40	2.60	10
05-30-2014	2.40	2.80	5
06-15-2014*	2.50*	2.80	5
06-30-2014	2.60	2.70	5

07-15-2014	2.60	2.70	6
07-30-2014	2.60	2.50	10
08-15-2014	2.60	2.70	12
08-30-2014	2.60	2.20	10
09-15-2014	2.60	2.70	17
09-30-2014	2.60	3.00+	22
10-15-2014	2.60	3.00+	20
10-30-2014	2.60	2.80	15
11-15-2014	2.70	2.70	12
11-30-2014	2.70	3.00+	20
12-15-2014	2.80	2.80	14
12-30-2014	2.80	2.90	6
* Place logs back into all bays to the 2.6 foot mark to begin holding water. Also drawing down water levels slightly lower in 2014 compared to 2013, to the 2.40 foot mark in early spring, has the potential to create more mudflat habitats for spring migrating shorebirds.			

Weekly vigilance of gage readings will be required to maintain water level scheme for CY 2014. The extent of stop-log manipulations will be very dependent on rainfall, weather and storm patterns. We experienced a relatively wet growing season from June to August of 2013, with excellent rainfall totals in June and July followed dry September and October months. This also supported above average wetland plant response of annuals in Unit III during the 2013 growing season (see precipitation info below).

Precipitation Information Relative to Water Level Control Manipulations	
Rainfall Data for Prime Hook NWR in 2013	**(1980-2010) Rainfall Norms for Sussex County**
Jan 2.46 (inches)	Jan 3.08 (inches)
Feb 1.40	Feb 2.96
Mar 3.61	Mar 4.32
Apr 2.25	Apr 4.19
May 2.51	May 3.80
Jun 7.27	Jun 3.67
Jul 6.27	Jul 4.21
Aug 4.89	Aug 6.00
Sept 1.04	Sept 3.96
Oct 1.32	Oct 3.38
Nov 2.73	Nov 3.50
Dec 5.74	Dec 3.49

VII. Management Strategy Documents File

Copy of Prime Hook NWR Prescribed Fire Plan: Project Name = PRIME HOOK GRASSLANDS, Complexity Rating = Moderate will be part of Section VII. The refuge burn plan for 2014 describes prescribed fire purposes, management goals, resource fire and fire operations objectives, fire behavior and weather conditions needed to conduct safe refuge-specific prescribed burn along with all required permits.

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APPENDIX A. Habitat Management Goal and Objective Statements Relevant to AHWP of 2014

Goal 1. (Barrier Beach Island and Coastal Salt Marsh Communities)

Manage, enhance and protect the dynamic barrier beach island ecosystem for migratory birds, breeding shorebirds and other marine fauna and flora. Perpetuate the biological integrity, diversity and environmental health of North Atlantic high and low salt marsh communities.

Objective 1.1 (Barrier Beach Island and Coastal Salt Marsh)

Maintain and monitor the dynamic nature and natural functioning of 1.5 miles of sandy beach, overwash dune-grassland and mudflat in Unit I parallel to the salt marsh management unit. Over time, permit the development of an additional 1.5 miles of these features and communities along the shore in Unit II, as salt marsh restoration is pursued. These area provide spawning habitat for horseshoe crabs, and nesting, foraging and staging habitats for breeding (American oystercatcher, piping plover, least and common terns) and migrating shorebirds

(especially Red Knot, Sanderling, Whimbrel) and other species of greatest conservation concern during critical periods (mid-March through mid-November). Barrier beach communities are characterized by the following attributes:

- Plant species typical of overwash grasslands include a mixture of *Cakile eduntula, Spartina patens, Schoenoplectus pungens, Cenchrus tribuloides, Triplasis purpurea,* and scattered *Baccharis halimifolia* seedlings
- Diagnostic dune grassland species consist of a mixture of *Ammophila breviligulata, Solidago sempervirens, Panicum amrum,* and *Opuntia humifusa*

When piping plovers, American oystercatchers, and/or least and common terns do nest, maintain suitable nesting habitat through beach closures, predator management, and public education to achieve minimum productivity rates, as defined within current recovery and management plans. Proposed productivity targets are as follows:

- 1.5 piping plover chicks per nesting pair on average over a five year period
- 0.35 American oystercatcher chicks per nesting pair
- 1 least or common tern per nesting pair

Goal 2. (Forested Habitats)

Manage the biological diversity, integrity, and environmental health of refuge upland and wetland forest cover types to sustain high quality habitats for migratory birds and increase quality habitat for the endangered Delmarva fox squirrel, forest interior breeding and wintering landbirds, reptiles, amphibians, and other forest-dependent wildlife.

Objective 2.2 (Mixed Hardwood Forest Restoration)

In the next 15 years, reduce forested habitat fragmentation and promote habitat connectivity between upland forest patches to improve quality habitat for the Delmarva fox squirrel and conserve focal forest interior dwelling birds. Restore appropriate old field and cropland areas to forest to reflect historic range of variability for mature upland forest vegetation to sustain the long-term viability of the squirrel. Create 870 additional acres of forested habitats to maintain at least two core habitat patches (~ 435 acres/patch) with connecting corridors.

Goal 3. (Refuge Impounded Marsh Complex)

Manage the quality of the wetland habitats within and surrounding the refuge's wetland impoundment complex for migrating shorebirds, breeding rails, wading birds, American black ducks, and migrating and wintering waterfowl consistent with the BIDEH policy. Support other native wetland-dependent species and provide fish passage and nursery habitats for anadromous fish species.

Objective 3.2 (Manage water quality and trust fishery resources, migratory birds)

Over the next 15 years protect and improve the water quality of 6,000 acres of impounded marsh and waterways, aquatic habitats and delineated buffer zones to provide clean water to safeguard and enhance the quality of breeding and nursery habitats for river herring (alewife, blue-back herring), American and hickory shad, striped bass, American eel, and other fishery resources, to conserve healthy populations of fish, breeding and migrating birds and resident wildlife.

Goal 4. (Early Successional Upland Habitats)

Manage, enhance and restore the native vegetation, biological diversity and ecological integrity of early successional upland habitats to create an assorted mosaic of early successional habitats mixed with transitional forested areas to conserve migratory birds, breeding landbirds, endangered species and to maximize benefits for other priority resources of concern.

Objective 4.1 (Transitional Habitats: Grassland, Shrublands and Young Trees)

Within the next 15 years restore and maintain early successional areas to represent the historic range of variability for upland transitional habitats. These habitats will be dominated by native vegetation reflecting several seral-stages that mimic natural conditions. Transitional habitats will usually be small in size and imbedded within a matrix of wetlands and upland forested habitats. Create a continuum of natural habitats to include a mosaic of grassland, transitional, young and old shrublands, and young forest habitats on 2,000 acres undergoing restoration to native vegetation.

Maintain at least 20% of the above acreage in an early successional (grassland and/or shrubland mix) to meet the needs of priority resources of concern. These habitats will support high priority breeding and migrating birds identified in BCR 30, PIF 44, DWAP and USFWS Birds of Conservation Concern lists that include prairie warbler, blue-winged warbler, Northern bobwhite, brown thrasher, whip-poor-will, willow flycatcher, eastern towhee, field sparrow, and Henslow's sparrow.

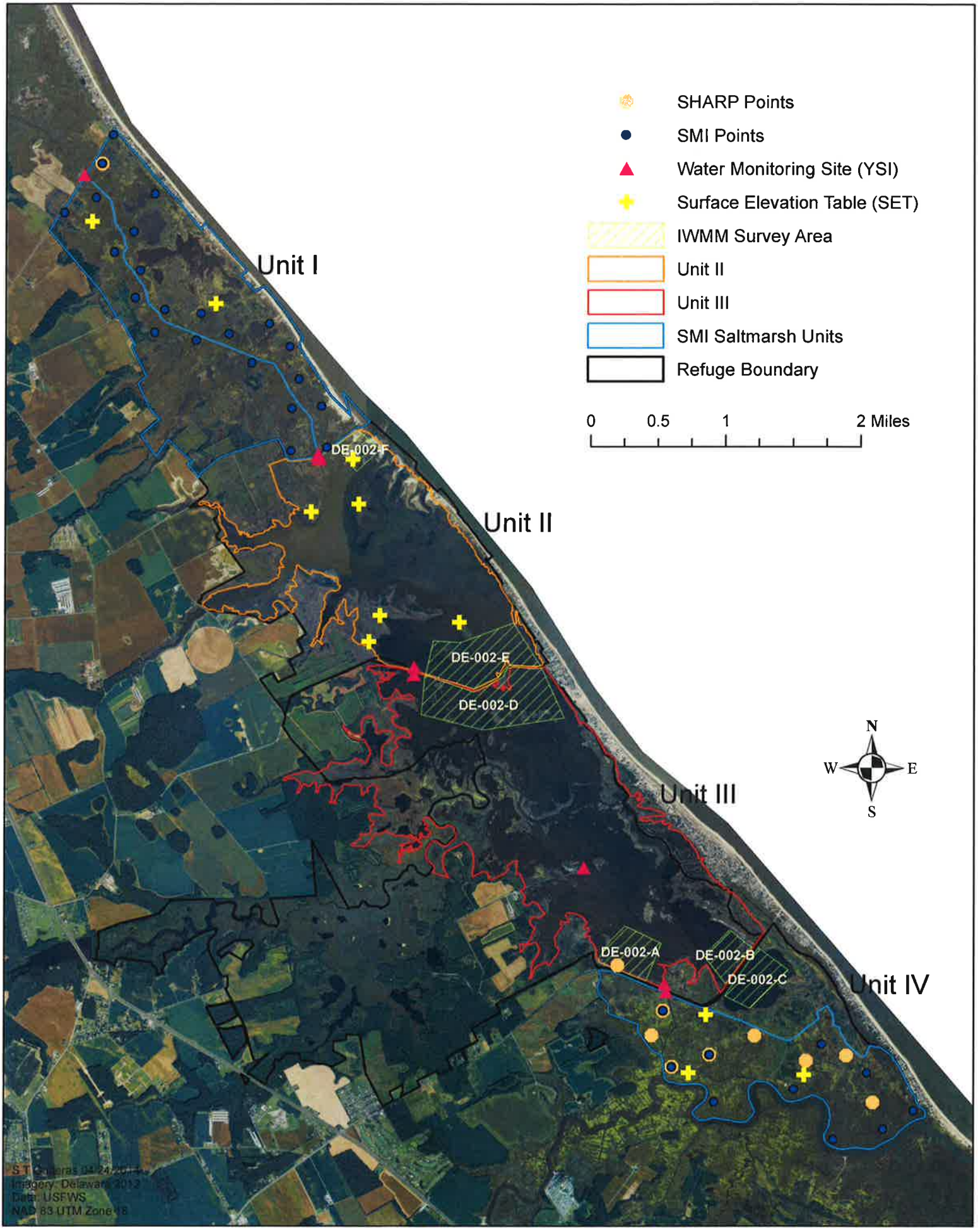
Objective 4.2

Manage for an interspersion of habitat structures for breeding,migrating and wintering bird species that utilize grasslands, during breeding as well as non-breeding season, by maintaining a mixture of short, medium and tall native grassland vegetation in areas of the refuge not well-suited to reforestation. This may be accomplished in varying amounts of rotation with

shrubland and forest management. This will provide breeding habitats for Northern bobwhite, Northern harrier, and other obligate grassland nesting birds, and also provide migrating and wintering habitats for Canada geese, shorebird and songbird species.

Specifically manage 50 hectares or more of grasslands adjacent to salt marsh habitat to meet the needs of breeding Henslow's sparrows and wintering Northern harriers. Habitat characteristics include patch sizes of no less than 30 ha &75 acres) in moderately tall grassy vegetation (> 30 cm) with well-developed litter layer, woody species accounting for less than 10% of habitat coverage, a forb component of about 25% and less than 10% invasive plants.

PRIME HOOK NWR MARSH & WATER MONITORING



Appendix C. CMECS Classifications for Refuge Management Units I, II and III.

CMECS Classification – Unit I

Biogeographic Setting

Realm: Temperate Northern Atlantic
Province: Cold Temperate Northwest Atlantic
Ecoregion: Virginian

Aquatic Setting

System: Estuarine
Subsystem: Coastal
Tidal Zone: Intertidal

Water Column Component

Water Column Layer: Estuarine Coastal Surface Layer
Salinity Regime: Upper Polyhaline Water (25 to < 30 pss)
Temperature Regime: Moderate Water

Hydroform

Hydroform Class: Current
Hydroform: Tidal Flow
Hydroform Type: Mixed Semi-diurnal Tidal Flow
Hydroform Class: Wave
Hydroform: Storm Surge

Geoform Component

Tectonic Setting: Passive Continental Margin
Physiographic Setting: Riverine Estuary
Geoform Origin: Geological/Anthropogenic
Level 1 Geoform: Beach/Canal-Excavated Channel
Level 1 Geoform Type: Barrier Beach
Level 2 Geoform: Fan
Level 2 Geoform Type: Washover Fan

Substrate Component

Substrate origin: Geologic Substrate
Substrate Class: Unconsolidated Mineral Substrate
Substrate Subclass: Fine Unconsolidated Substrate
Substrate Group: Sand
Substrate Subgroup: Medium Sand

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Emergent Wetland
Biotic Subclass: Emergent Tidal Marsh
Biotic Group: Low and Intermediate Salt Marsh
Biotic Community: *Spartina alterniflora-Distchlis spicata,* Tidal Herbaceous

CMECS Classification – Unit II

Biogeographic Setting

Realm: Temperate Northern Atlantic
Province: Cold Temperate Northwest Atlantic
Ecoregion: Virginian

Aquatic Setting

System: Estuarine
Subsystem: Coastal
Tidal Zone: Intertidal

Water Column Component

Water Column Layer: Estuarine Coastal Surface Layer
Salinity Regime: Lower Polyhaline Water (18 to < 25 pss)
Temperature Regime: Moderate Water

Hydroform

Hydroform Class: Current
Hydroform: Tidal Flow
Hydroform Type: Mixed Semi-diurnal Tidal Flow
Hydroform Class: Wave
Hydroform: Storm Surge

Geoform Component

Tectonic Setting: Passive Continental Margin
Physiographic Setting: Riverine Estuary
Geoform Origin: Geologic/Anthropogenic
Level 1 Geoform: Beach/Artificial Dike
Level 1 Geoform Type: Barrier Beach/Canal-Water Control Structure
Level 2 Geoform: Inlet
Level 2 Geoform Type: Tidal Inlet

Substrate Component

Substrate Origin: Geologic Substrate
Substrate Class: Unconsolidated Mineral Substrate
Substrate Subclass: Fine Unconsolidated Substrate
Substrate Group: Muddy Sand
Substrate Subgroup: Silty Sand

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Emergent Wetland
Biotic Subclass: Emergent Tidal Marsh
Biotic Group: Low and Intermediate Salt Marsh
Biotic Community: *Spartina alterniflora-Distchlis spicata,* Tidal Herbaceous

CMECS Classification – Unit III

Biogeographic Setting

Realm: Temperate Northern Atlantic
Province: Cold Temperate Northwest Atlantic
Ecoregion: Virginian

Aquatic Setting

System: Estuarine
Subsystem: Coastal
Tidal Zone: Intertidal

Water Component

Water Column Layer: Estuarine Coastal Surface Layer
Salinity Regime: Mesohaline Water (5 to < 18 pss)
Temperature Regime: Moderate Water

Hydroform

Hydroform Class: Current
Hydroform: Tidal Flow
Hydroform Type: Mixed Semi-diurnal Tidal Flow
Hydroform Class: Wave
Hydroform: Surface Wind Wave

Geoform Component

Tectonic Setting: Passive Continental Margin
Physiographic Setting: Riverine Estuary
Geoform Origin: Anthropogenic
Level 1 Geoform: Artificial Dike
Level 1 Geoform Type: Artificial Levee
Level 2 Geoform: Mosquito Ditch

Substrate Component

Substrate Origin: Geologic Substrate
Substrate Class: Unconsolidated Mineral Substrate
Substrate Subclass: Fine Unconsolidated Substrate
Substrate Group: Sandy Mud
Substrate Subgroup: Sandy Silt Clay

Biotic Component

Biotic Setting: Benthic/Attached Biota
Biotic Class: Emergent Wetland
Biotic Subclass: Emergent Tidal Marsh
Biotic Group: Brackish
Biotic Community: *Schoenoplectus americanus – (Spartina patens-Typha* spp) Herbaceous Vegetation

Appendix D. Prime Hook NWR IWMM Waterbird Species List and Phenology Table.

Prime Hook National Wildlife Refuge IWMM Waterbird Species List and Phenology					
AOU Species Code	**Departing Winter Resident April**	**Migrants to Breeding Grounds (Mar 1 – June 1)**	**Local Breeders (April 1 – Sept 1)**	**Migrants to Wintering Grounds (Jul 1 – Oct 1)**	**Arriving Winter Resident (Sept 1 – April 1)**
AMAV		XXXXX		XXXXX	
AMBI					
ABDU	XXXXX	XXXXX	XXXXX		XXXXX
AMCO	XXXXX				XXXXX
AMOY		XXXXX	XXXXX	XXXXX	
AWPE	XXXXX				XXXXX
AMWI	XXXXX				XXXXX
AMWO		XXXXX			
BASA		XXXXX		XXXXX	
BLRA			XXXXX		
BLSC	XXXXX				XXXXX
BLSK		XXXXX	XXXXX	XXXXX	
BLTE				XXXXX	
BBPL		XXXXX		XXXXX	
BCNH				XXXXX	
BNST			XXXXX	XXXXX	
BWTE	XXXXX				XXXXX
BRAN	XXXXX				XXXXX
BBSA				XXXXX	
BUFF	XXXXX				XXXXX
CANG	XXXXX		XXXXX		XXXXX
CANV	XXXXX				XXXXX
CATE				XXXXX	
CAEG				XXXXX	
CLRA			XXXXX		
COLO					XXXXX
COME	XXXXX				XXXXX
COMO				XXXXX	
COTE		XXXXX		XXXXX	
DCCO	XXXXX				XXXXX
DUNL	XXXXX	XXXXX		XXXXX	XXXXX
EUWI				XXXXX	
FOTE		XXXXX		XXXXX	
GADW	XXXXX				XXXXX
GBHE	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
GLIB		XXXXX		XXXXX	
GREG		XXXXX		XXXXX	
GRSC	XXXXX				XXXXX
GRYE	XXXXX	XXXXX		XXXXX	XXXXX
GRHE				XXXXX	
GBTE				XXXXX	

Prime Hook National Wildlife Refuge IWMM Waterbird Species List and Phenology					
AOU Species Code	**Departing Winter Resident -April**	**Migrants to Breeding Grounds (Mar 1 – June 1)**	**Local Breeders (April 1 – Sept 1)**	**Migrants to Wintering Grounds (Jul 1 – Oct 1)**	**Arriving Winter Resident (Sept 1 – April 1)**
HOME	XXXXX				XXXXX
KILL			XXXXX		
LESA		XXXXX		XXXXX	
LETE		XXXXX		XXXXX	
LEYE		XXXXX		XXXXX	
LBHE				XXXXX	
LBDO				XXXXX	
MALL	XXXXX				XXXXX
MAGO		XXXXX		XXXXX	
NOPI	XXXXX				XXXXX
NSHO	XXXXX				XXXXX
PBGR	XXXXX				XXXXX
PIPL		XXXXX		XXXXX	
REKN		XXXXX		XXXXX	
RBME	XXXXX	XXXXX			XXXXX
RNPH		XXXXX		XXXXX	
RNDU	XXXXX				XXXXX
ROGO	XXXXX				XXXXX
ROYT		XXXXX		XXXXX	
RUDU	XXXXX				XXXXX
RUTU		XXXXX		XXXXX	
SAND	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
SACR		XXXXX		XXXXX	
SATE				XXXXX	
SEPL		XXXXX		XXXXX	
SBDO	XXXXX	XXXXX		XXXXX	XXXXX
SNGO	XXXXX				XXXXX
SNEG		XXXXX		XXXXX	
SOSA		XXXXX		XXXXX	
SORA				XXXXX	
SPSA		XXXXX		XXXXX	
STSA		XXXXX		XXXXX	
TRHE		XXXXX		XXXXX	
TUSW	XXXXX				XXXXX
WESA		XXXXX		XXXXX	
WHIB		XXXXX		XXXXX	
WHIM		XXXXX		XXXXX	
WILL			XXXXXX		
WIPH		XXXXX		XXXXX	
WISN					
WODU	XXXXX				XXXXX